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AUTOMATIC WATER QUALITY MONITORING OF TWO LOTIC ECOSYSTEMS IN THE ATLANTIC REGION

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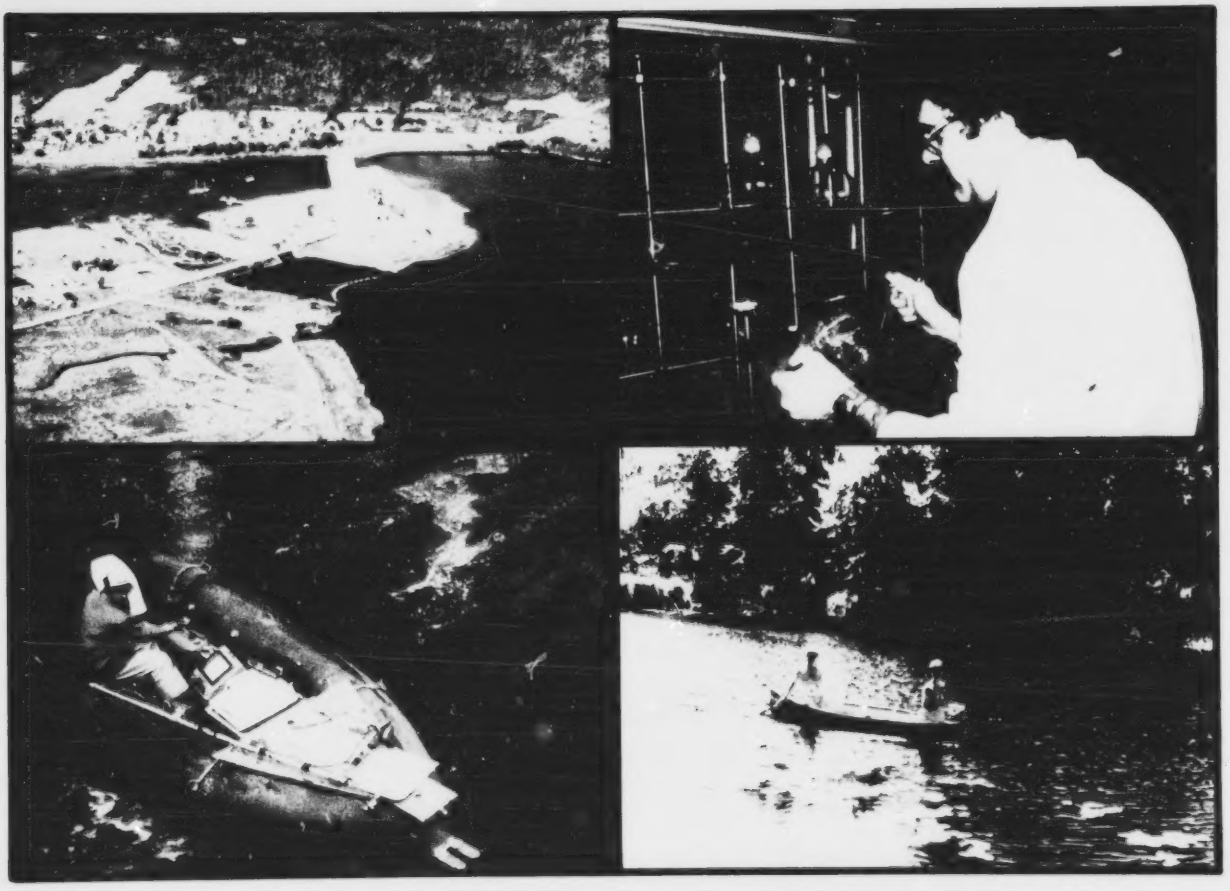

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INLAND WATERS DIRECTORATE
ATLANTIC REGION
WATER QUALITY BRANCH
MONCTON, NEW BRUNSWICK

AUTOMATIC WATER QUALITY MONITORING

OF TWO LOTIC ECOSYSTEMS IN THE

ATLANTIC REGION

Technical Report IW/L-AR-WQB-88-134

Inland Waters/Lands Directorate

Conservation and Protection

Environment Canada

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1. ABSTRACT

Automatic Water Quality Monitors (AWQM's) were installed at the Big Presque Isle Stream from May 1986 to September 1986 and at the Mersey River from October 1986 to April 1987. They provided a large data base, which was analysed for processes occuring in each of the study sites. Parameters measured at the Big Presque Isle Stream included dissolved oxygen (DO), pH, specific conductance, water temperature, air temperature and photosynthetic active radiation (PAR), while at the Mersey River, they were limited to pH, conductivity, water temperature and air temperature. Results showed high DO and pH diurnal fluctuations in the Big Presque Isle Stream, especially during high PAR periods, indicating that the system is highly productive. In the Mersey River, in spite of low conductivity and winter temperatures, good data were recorded, and a noticeable pH depression occured during spring snowmelt.

Although these processes were identified with the data provided by the AWQM's, there were still some periods when data were not transmitted, or the signals shifted relative to calibration values. These problems were especially frequent at the Big Presque Isle Stream site, because of the effects of some accumulation of debris and algae on the probes or of an improper earth ground system. At the Mersey River, the difficulties were few, even though the probes were exposed to cold winter conditions.

When considering the data bases generated by AWQM's, they are thereby rated as very useful for certain studies, provided that the environmental conditions enable good functioning of the probes.

2. RESUME

Ce rapport consiste en une analyse et une interprétation des données accumulées par un enregistreur automatique de la qualité des eaux, installé au ruisseau Big Presque Isle de mai à septembre 1986 et à la rivière Mersey d'octobre 1986 à avril 1987. Le montant d'oxygène dissout (DO), le pH, la conductivité, la température de l'eau, la température de l'air et la quantité de radiation solaire photosynthétique (PAR) ont tous été mesurés au ruisseau Big Presque Isle. A la rivière Mersey, les paramètres mesurés furent le pH, la conductivité, la température de l'eau et la température de l'air. Les données recueillies par l'enregistreur automatique ont démontré, par d'importantes fluctuations diurnes du pH et du niveau d'oxygène dissout, que le ruisseau Big Presque Isle avait une grande productivité primaire dépendante de la quantité de radiation solaire. Les données prises de la rivière Mersey ont démontré une baisse du pH de l'eau pendant la fonte des neiges printanière.

Certains problèmes ont survenu lors de la période de contrôle. Il y eut quelques interruptions dans la transmission des données et des corrections ont parfois dû être appliquées sur la courbe de certains paramètres. Ces problèmes ont surtout été rencontrés au ruisseau Big Presque Isle, où l'accumulation d'algues et de débris

sur les électrodes et l'effet de la terre sur les conduits électriques ont été fréquemment rencontrés. Au site de la rivière Mersey, les difficultés étaient moindres, même si l'équipement était exposé à des températures basses.

L'utilité des enregistreurs automatiques de la qualité des eaux s'avère donc très grande, puisqu'ils permettent une accumulation importante de données. Cependant, ils doivent être utilisés avec précautions, parce qu'ils vont fonctionner correctement seulement si les conditions environnementales leur sont favorables.

3. INTRODUCTION

Automatic Water Quality Monitors (AWQM's) provide high frequency surveillance of aquatic systems. Contrary to manual collection, AWQM data are not limited to the hours within the work day. This makes them particularly useful for certain situations when frequent data are needed, or where the site is rather remote.

The Water Quality Branch - Atlantic Region's first experience with AWQM's was in 1970, when eight were purchased for the monitoring of the Saint John River Basin, following a trans-boundary dispute on waste discharge in the Big Presque Isle Stream (Cullen, 1975). In 1975, the AWQM project was cut back to only one developmental AWQM at Grand Falls, because of problems with the reliability of the data (Belliveau and Lockerbie, 1981). New AWQM's were installed at the Mersey River during the winters of 1984-85 and 1985-86, and at the Big Presque Isle Stream during summer 1985, but these installations produced only a small number of useful data (Howell, pers. comm.). In the interim, some of the technical problems that were encountered have been addressed. These improvements, coupled with the positive aspects of past experiences, bode well for future applications of these instruments.

In other parts of the country, Crosley and Munro (1984) attempted a trial experiment with AWQM's to monitor the Souris River in Saskatchewan. They encountered many problems, since the

self-standardization system purchased proved inappropriate for use in rivers with high levels of suspended solids. Also, winter shutdowns and other problems resulted in collection of only 50% of the available data. On the other hand, a study by Whitfield and Dalley (1987), which consisted of measuring the effects of storm events on the pH of a river in British Columbia with an AWQM, proved to be much more successful. They were able, using data collected at 15 minute intervals, to measure the lag period from the beginning of the storm to changes in river discharge and pH.

Based on the positive aspects of past experience and new developments, two AWQM's were installed in the Atlantic Region during 1986-87. One was located at the Big Presque Isle Stream in New Brunswick from May to September 1986, while the other was installed in the Mersey River in Nova Scotia from October 1986 to April 1987.

The Big Presque Isle Stream, which has been subjected to excessive nutrient supply from agricultural runoff (Anonymous, 1974), was chosen in order to study the diurnal changes in an eutrophic stream. The hourly data may provide significant information concerning the interrelationships between DO production, pH, solar irradience and other parameters in a highly productive system.

The Mersey River, in contrast, is highly sensitive to acid precipitation because of limited buffering capacity of the bedrock

(Hirvonen, 1984). It is affected by both the organic acidity found in coloured waters and by mineral acidity due mainly to anthropogenic sources (Kerekes et al., 1986). Since it is known that acidic storms and snowmelts can increase the hydrogen ion concentration in lakes and rivers (Barker and Witt, 1984; Whitfield and Dalley, 1987), this part of the study consisted of monitoring the river with the use of an AWQM during the winter and spring snowmelt event for detection of possible pH depressions. Other similar studies have been conducted in other regions (Henriksen and Wright, 1977; Jeffries, et al., 1979; and Papineau, 1986), but such a study had not yet been done in the Atlantic Region.

In addition to the presentation and interpretation of the results, this report will also evaluate the ability of AWQM's to collect reliable data in two different lotic ecosystems, exposed to many inclemencies such as algal growth, ice formation and cold water temperatures.

4. MATERIAL AND METHODS

4.1 Study Site Description

4.1.1 Big Presque Isle Stream

The Big Presque Isle Stream is a trans-boundary stream between Maine and New Brunswick, and is part of the Saint John River Basin (Fig. 1). Bordering the stream are many agricultural fields and a few municipalities, such as Easton, Westfield and Mars Hill on the American side and Tracey Mills and Centreville on the Canadian side.

The study site was located on the Big Presque Isle Stream at the Water Resources Gauge Station at Tracey Mills, New Brunswick (lat. 46° 24′ N long. 67° 37′ W).

4.1.2 Mersey River

The Mersey River is a relatively large river system located in southwest Nova Scotia (Fig. 2). It drains large lakes, such as Eleven Mile Lake and Kejimkujik Lake, and it passes through Kejimkujik National Park.

Hirvonen (1984) determined that 60% of the Mersey River Basin is highly sensitive to acid precipitation, since the bedrock is mostly granite or slates with quartzite and greywacke

(Gimbarzevsky, 1975). The area is 94% covered with coniferous, deciduous and mixed forests, while wetlands cover most of the rest of the area (Gimbarzevsky, 1975).

The study site was located on the Mersey River (lat. 44°26'N long. 65°13'W) above Mill Falls in the Kejimkujik National Park, near the Park's headquarters (see Fig. 2).

4.2 Probe Packages

4.2.1 Big Presque Isle Stream

A variety of systems with different probe combinations were evaluated at the Big Presque Isle Stream site (Fig.1), and these are shown in Table 1. The two main probe packages were the Montedoro-Whitney Type A water quality probes and the Enviro-Labs water quality probes. Performance specifications for the Montedoro-Whitney system are shown in Appendix 1, while those for the Enviro-Labs system are displayed in Appendix 2.

The probes were in place from May 22 to September 11, 1986 in a large metal cage to protect them from floating debris and excessive plant growth. A Data Collection Platform (DCP) and other related equipment were set up in the gauge house which had a source of AC power.

A Manning Philips Autosampler was also installed during the same period, and it collected water samples automatically at 24-hour intervals. These samples were used for laboratory analysis of total phosphorus, total nitrogen and DOC and the results are presented in this report.

4.2.2 Mersey River

The probe packages for the automatic monitoring of the Mersey River (Table 1) were limited to the Montedoro-Whitney Type A water quality probes and to an Analog Devices AD 590 Temperature Sensor and Amplifier Circuit. These were installed near the Kejimkujik National Park Headquarters from October 20, 1986 to April 30, 1987 in a metal cage at the bottom of Mersey River above Mill Falls (Fig.2), and were thus protected from ice. The DCP was located inside the park headquarters building, and AC power was used.

Included in the report are meteorological and snow chemistry data from the Atmospheric Environment Service (AES) CAPMoN precipitation site, near Mill Falls (Fig. 2).

4.3 Data Capture and Transmission

The data were transmitted automatically by the DCP Handar 560A at both study sites. At the Big Presque Isle Stream, two eight-channel analog boards were used, and the Weston & Stack and Enviro-Labs probes were connected differentially, using two

channels per probe. Only one eight-channel analog board was used for the Mersey River.

On an hourly basis at each site, the average of 20 readings taken at 2-second intervals for each probe was calculated and subsequently transmitted to the GOES satellite. Standard deviations of these readings were also calculated and transmitted for the Mersey River site. Every third hour, the satellite transmitted the accumulated data to the receiving station in Maryland. It was then collected daily in Moncton from the Water Resources Branch computer in Halifax. The latest data received each day were readings taken early that morning.

Data transmission of the Big Presque Isle Stream was sometimes interrupted during the study period. These interruptions are shown in Figure 3.

4.4 Parameter Specifications

4.4.1 Big Presque Isle Stream

The choice of parameters monitored for the Big Presque Isle Stream was made based on the observation that it is a highly productive system (Anonymous, 1977). These parameters were DO, pH, specific conductance, water temperature, air temperature and PAR (photosynthetic active radiation).

Dissolved oxygen concentrations in the water depend on physical, chemical and biochemical activities, and thus undergo diurnal and seasonal fluctuations (McNeely, et al., 1979). Dissolved oxygen data give significant information to this study, since they are indicators of the rate of primary production which was not measured. Dissolved oxygen is either measured with a membrane electrode or with the Winkler method (American Public Health Association, et al., 1985).

pH is a measure of the hydrogen ion activity (American Public Health Association, et al., 1985). In the Big Presque Isle Stream, diurnal pH fluctuations give a good indication of the temporal relations between pH, DO production and PAR.

Conductivity, a measure of the water's ability to carry an electrical current, represents the ionic composition of water and estimates the dissolved solids concentration (American Public Health Association, et al., 1985). When combined with discharge data from the Water Resources Branch, specific conductance enables one to detect any dilution occuring in the stream, mostly due to important rain events.

Finally, water temperature, air temperature and PAR were recorded at the Big Presque Isle Stream site. They are physical factors that can significantly affect aquatic processes. Water temperature is dependent upon air temperature and PAR, and higher water temperatures are known to increase the water's conductivity,

and to decrease the solubility of oxygen in the water. The PAR affects the photosynthetic activity in an aquatic system, and its effect will be reflected by parameters such as DO, pH and water temperature.

4.4.2 Mersey River

Four parameters were chosen for the automatic monitoring of the Mersey River during the study period: pH, specific conductance, water temperature and air temperature.

The most important parameter measured was the pH, since the dilute Mersey River is exposed to acidic precipitation and meltwater. Extreme conditions for the measurement of pH were present, that is a low conductivity of around 30 μS/cm, and a water temperature that usually stabilizes at 0° Celsius during this season.

Specific conductance was measured in order to detect any ionic composition changes in the Mersey River throughout the winter. The other parameters, such as water temperature and air temperature, delineate periods of ice formation, snowpack accumulation and melt, while discharge, snowpack depth, sulphate and nitrate-nitrite ion concentrations, and other parameters measured on grab samples were chosen to delineate the dynamics within the snowpack, and the effects on river pH.

4.5 Calibrations and Probe Evaluation

4.5.1 Big Presque Isle Stream

Field checks were carried out at least once a month. Table 2 displays field (calibration) and AWQM sensor readings for the parameter for every field trip.

The AWQM was verified using the following portable field meters. Validity checks of the AWQM DO values were done either with a YSI Model 57 DO Meter or with the Winkler titration. The specific conductance reading was compared with that of a Hydrolab TC-2 Conductivity Meter, while the AWQM pH probe value was compared with either a PHM80 Portable pH Meter or with a Corning pH-Temp Meter 4.

4.5.1.1 Montedoro-Whitney System

When installed on May 20, the Montedoro-Whitney (MW) system worked well. During the following field checks, that is June 11-12, July 16-17 and July 30, probes were first shaken to free them from debris, then the DO membrane and electrolyte were replaced, and the probes were recalibrated. Also many field readings were taken during the field trips, and were used to calculate the correction equations (see Appendix 3). The data that will be used for the interpretation, including graphs, are mostly corrected values calculated from these equations.

Compared to field reference values (Table 2), the MW DO probe was reading high, even with a correction applied and thus the data were considered unreliable. The conductivity values measured with the MW probe appeared to compare well with the reference values (Table 2), but raw data reveals extreme drifts, as high as 450μS/cm in June or as low as 50 μS/cm in July. In August, the conductivity readings stayed low throughout the month until it was removed on August 21. These measurements were thus judged unreliable and were not used.

pH (corrected) and water temperature measurements of the MW system were both considered reliable, since the values of these parameters did not deviate greatly from calibration values (Table 2).

Therefore, the MW system provided reliable data for pH and water temperature, but the conductivity and DO values could not be used for data interpretation.

4.5.1.2 Enviro-Labs System

Upon installation on May 20 at the Big Presque Isle Stream, the Enviro-Labs probes, except for the conductivity probe, were subsequently found to be affected by earth ground. On June 11-12, the pH (pH E) and DO (DO E) probes were grounded, but the DO probe could not be calibrated and caused the pH probe signal to drop to

approximately 3 volts. The DO E probe was therefore removed. The pH E probe was then recording accurately, but had to be readjusted to higher values the next day. The pH E probe was later connected differentially (June 23), but it was discovered on the final day of the monitoring (September 11), that it had failed since the last field trip (Aug. 21-22). By analysing the data generated by the pH E probe, it was considered undependable because of its differences with the calibration values (see Table 2).

Consequently, the only acceptable data recorded by the Enviro-Labs system were the specific conductance measurements. Indeed, the probe measured quite accurately the conductivity in the Big Presque Isle Stream especially after July 30, when the probe was cleaned and set vertically in the river.

4.5.1.3 Others

Another probe used in the automatic monitoring of the Big Presque Isle Stream was the Weston Stack Dissolved Oxygen Analyser Model 330. This probe was set in the stream on June 23, after the DO E probe had failed to work properly. The values of the Weston Stack (WS) DO probe compared well with the calibration values, since only slight adjustments to higher values were made on July 30 and August 21 (Table 2). Therefore, the DO WS probe was judged to be most accurate of the DO probes, and its values will thus be used for the data interpretation.

No significant problems occured with the PAR and the air temperature sensors, so the unedited data will be used in this report.

4.5.1.4 Summary

A probe evaluation for the Big Presque Isle Stream site is presented below:

Probe	Period of data recording	Observations
pH MW	May 22 - Sept 11	Corrected values used; slight drifting at first, but reliable data after July 15.
pHE	June 16 - Aug 25	Not accurate, extreme drifting.
DO MW	May 22 - Sept 11	Not accurate, extreme drifting.
DOE	May 22 - June 12	Did not function properly
DO WS	June 23 - Sept 11	Corrected values used; low values after July 15
S.C. MW	May 22 - Sept 11	Not accurate, extreme drifting and very low values in August
S.C. E	May 22 - Sept 11	Accurate data especially after July 30, when probe was set vertically in the cage
WT MW	May 22 - Sept 11	Accurate data
AT	May 22 - Sept 11	Accurate data
PAR	May 22 - Sept 11	Accurate data

Many problems occured with the AWQM in the Big Presque Isle Stream during summer 1986. Accumulation of algae growth and debris on the probes, earth ground effects, and interference between the systems seem to have affected the reliability of some probes. Even though some probes were evaluated as more accurate than others, there were still many adjustments to make on the data, including calibrations and the application of correction equations. Therefore, the interpretation of the AWQM data for the Big Presque Isle Stream needs to be approached with caution, and calibration values must be relied upon constantly.

4.5.2 Mersey River

Fewer calibrations were done on the AWQM at the Mersey River (see Table 3), but close surveillance of the pH curve was established with frequent field readings using an Ingold Acid Rain Electrode (weekly for study period, and daily during and after the snowmelt event, that is from March 23 to April 21). Also, some intercept adjustments were made on October 23, January 22 and March 12, according to calibration values taken with the PHM80 Portable pH Meter. However, the probe could not be visibly checked as it was under river ice, though fouling is not a concern during winter studies.

Although the conductivity sensor was not calibrated, reference values were taken during field checks with the Hydrolab TC-2 Conductivity Meter.

4.5.2.1 Montedoro-Whitney System

The Montedoro-Whitney Type A water quality probes that were used in the Mersey River during winter 1986-87 have provided good reliable data. The pH measurements tended to drift to higher values, but during the snowmelt, the AWQM pH values coincided well with the laboratory values. The pH MW probe was therefore providing reasonable data, especially following calibrations.

No problems were encountered with the MW conductivity probe, since no calibrations were needed during the study period. However, the water temperature probe started to give unreasonable data at the end of March, with temperatures as high as 25° Celsius. This problem occured only at the end of the study period though, so both the conductivity and the water temperature probes can be considered reasonably efficient in low temperature waters.

Finally, the Analog Devices AD590 Temperature Transducer and Amplifier Circuit for air temperature worked well at the Mersey River, even in sub-zero temperatures.

4.5.2.2 Summary

The Montedoro-Whitney system proved to be an appropriate probe package for winter studies, as the one at Mersey River, when low water temperatures exist. Indeed, the probes measured the river

chemistry generally well, even though there was limited calibration. Therefore, the data interpretation for the Mersey River site can be done with more confidence, given the more reliable AWQM data.

5. RESULTS AND DISCUSSION

5.1 Big Presque Isle Stream

5.1.1 Dissolved Oxygen and PAR

The AWQM hourly DO data measured with the Weston Stack probe, in addition to PAR and the DO saturation curve, are plotted by ten day intervals in Figures 4 to 11. The area delineated by the DO curve and the minimum values of each day represents an estimate of daily gross DO production. This surface can be further subdivided by using the DO saturation curve to give an estimate of daily net DO production. Given that gas exchange exists at the air-water interface in an open system such as a stream, and that oxygen supersaturation in the water implies a diffusion of oxygen towards the atmosphere, then these net DO values provide only indications that there was some oxygen produced that was not entirely used by respiration in the system. Both gross DO and net DO estimates will be used in further data analysis, and the results are shown in Table 4.

Basic statistics on the DO measurements are shown in Table 5 as a general overview of the results found. A total of 1416 DO measurements were taken by the WS probe. The calculated mean DO concentration after the correction was 8.43 mg/L, while the data ranged between 2.70 and 13.22 mg/L (Table 5). The lower DO value of 2.7 mg/L occurred before the calibration of July 30, when the

probe had drifted to extremely low values (Fig. 7). Important diurnal fluctuations, some as high as 6 mg/L, were observed, and this indicates the high photosynthetic activity in the Big Presque Isle Stream (Anonymous, 1974).

According to Table 6, the DO concentration peaked during the day at 1340 hours from July to September. This meant that the DO concentration peaked approximately an hour after the PAR peaked at 1300 hours. These results differ from those observed by Schurr and Reichti (1975), who found that in several Swiss rivers, the time lag between DO maxima and light intensity was 2.2 hours. In this study, providing that the one-hour time lag was accounted for, a positive correlation was observed between DO and PAR ($R = 0.47$, $R^2 = 0.22$; $P < 0.05$). Therefore, diurnal fluctuations in the DO of the river were indeed affected by the light intensity.

The relationship between these two parameters was also verified by applying correlations between the integrated values of gross DO, net DO and PAR in certain periods when the data were uninterrupted. Gross DO and PAR were positively correlated from July 1 to 17 and from August 12 to 20 ($P < 0.05$), while no correlation was detected between August 22 and September 4. However, net DO and PAR values were not correlated to each other during any of these periods. This indicates that the estimated gross DO values, were well in accordance with the PAR values, while the net DO measurements provided poor estimates of the oxygen production in the stream. An explanation of these results is the

fact that since the DO curve sometimes drifted down between calibrations, the saturation curve would cross the DO curve higher than it should have. Consequently, the DO variations would be correct, but the estimate of the amount of oxygen used for respiration would be biased high. Although the DO measurements are only estimates of the primary productivity in the stream, it can be noted that the ratio of net DO/gross DO was generally lower than 40%, while Smith (1980) estimated a ratio of NPP (net primary productivity)/GPP (gross primary productivity) of 40 to 80% for plants such as phytoplankton. We note that higher NDO/GDO ratios occurred during or following calibrations, such as from June 27 to July 2 and from July 14 to 17 (Table 4). Also, August 13 to 23 was a period of high net DO production (Table 4), suggesting good DO measurements for that period (Fig. 9).

The nutrient status of a river system is expected to influence the primary productivity. In the Big Presque Isle Stream, total phosphorus, total nitrogen and DOC were measured daily, and their concentrations are shown in Table 4 and in Fig. 12 and 13. The total phosphorus ranged between 0.004 and 0.10 mg/L, the total nitrogen values between 0.26 and 1.20 mg/L and DOC between 2.9 and 13.0 mg/L (Table 4). The total phosphorus values were within the desirable concentration of 0.1 mg/L (McNeely et al., 1979), while the total nitrogen was often over 0.5 mg/L, meaning the presence of excessive organic inputs (McNeely et al., 1979). The DOC was mostly over 3.0 mg/L (mean 5.2 mg/L) indicating an influence of organic inputs such as agricultural runoff and high photosynthetic

activities (McNeely, et al, 1979). There is indeed a major influence on water quality by agricultural practices on the Big Presque Isle Stream (Anonymous, 1977).

The ratio, total nitrogen/total phosphorus, was calculated for each day of the whole study period, and the mean ratio was 45.6. Since a ratio of approximately 10 is the limit for a nitrogen-limited ecosystem, it seems likely that the stream is phosphorus-limited. However, the water samples for the nutrients analysis were subsampled from plastic bottles, and it is possible that some of the phosphorus may have attached to the sides of the bottle. Therefore, the total phosphorus levels may have been biased low.

The DOC underwent an increase during the study period, such that starting August 1, the DOC levels exceeded the 5 mg/L level (Fig. 13). Such an increase could be due to intensive photosynthesis in the river or simply to more outputs from the agricultural lands (McNeely, et al., 1979). The total phosphorus also seemed to have higher levels in August, while the total nitrogen underwent a general decrease in the middle of July (Fig. 12). They both peaked on August 26 and on August 31 (Fig. 12), and from Fig. 23, it can be observed that a peak in discharge occurred on August 25. This peak is probably related to an important rain event, that would have increased agricultural runoff, and thus the nutrients in the river by August 26. The nutrient peak on August 31 occurred at a time of high PAR and DO production (Fig. 10).

The nutrient supply could not be statistically linked to the DO production or discharge, since none of the correlations was significant. Many other factors affect the DO concentrations, so the high levels of nutrients in the water are only an indication that eutrophic conditions exist in the Big Presque Isle Stream (Anonymous, 1974).

5.1.2 Specific Conductance and Discharge

The specific conductance, measured with the Enviro-Lab probe, and the calibration values are plotted in Fig. 14 to 24, with the hourly discharge values. There were 2071 hourly values recorded for the specific conductance, which ranged between 132 and 461 μS/cm, with a calculated mean of 296 μS/cm (Table 5).

Before the first calibration on June 11, the conductivity values did not seem to fluctuate diurnally (Fig. 14 and 15), but they seemed to correlate negatively with the discharge. This indicates that the increase of discharge caused a dilution of the ions in the water, and this is readily apparent during major rain events. After the first calibration, the data started to show some diurnal variations (Fig. 16 to 24). There was still a relationship between the specific conductance measurements and the discharge, since a negative correlation occurred between the two parameters ($R = -0.54$, $R^2 = 0.29$; $P < 0.05$).

5.1.3 pH, Water Temperature and Air Temperature

The corrected pH curve was plotted with the water temperature and the air temperature curves, and they are presented in Figures 25 to 35.

Before the first calibration on June 11-12, the pH curve had drifted down (Fig. 27). After the adjustment, the data calibrated well throughout the rest of the study period. On some days, however, the readings deviated somewhat from the usual pattern, as on June 27-29 (Fig. 28), on July 3 (Fig. 29) and on July 21 (Fig. 31).

Over the study period, the corrected pH data ranged from 4.57 to 9.74, with a calculated mean of 7.85 (n = 2083) (Table 5). These results represent the unedited data, while in the graphs, a few values were deleted in June because of unrealistically high or low readings.

Strong daily fluctuations of almost 1 pH unit can be observed thus supporting the observation that the Big Presque Isle Stream is highly productive (Anonymous, 1977). When isolating the data between July and September, it was determined that the pH peaked on an average at 1730 hours (Table 6). This represents a time lag of 4.5 hours with the PAR peak, and 3.8 hours with the DO peak, which are much longer time lags than the ones determined by Schurr and Rutchi (1975). They calculated a 2.62 hour lag period between pH

and light intensity maxima, and 0.42 hour time lag between pH and DO peaks. Their results were based, however, on sunny days when ideal sunlight would be available. This may cause some differences, since our study includes all the days when data were available, but the differences could also be a function of the levels of dissolved calcium and alkalinity.

By correcting the five hour lag phase between pH and PAR peaks and the four hour lag phase between pH and DO maxima, correlations were applied on the data. pH was positively related to both the DO concentrations ($R = 0.40$, $R^2 = 0.16$, $P < 0.05$) and the PAR ($R = 0.50$, $R^2 = 0.25$; $P < 0.05$).

The relationship between these three parameters was also verified by using the integrated daily values during certain periods of the summer. High correlation were found between pH and PAR from July 4-17 ($R = 0.86$, $R^2 = 0.75$, $P < 0.05$) and from August 12-20 ($R = 0.81$, $R^2 = 0.66$; $P < 0.05$), while no significant relationship was detected between June 1-10 and August 22-30. A possibility exists that some drifts in the data could have affected these relationships during certain periods. The best relationship though was between gross DO and pH, since the R was highly significant ($R = 0.57$, $R^2 = 0.32$; $P < 0.05$), and the data set was not subdivided. This is to be expected as increased photosynthesis rates will increase both the pH and DO in the stream.

As seen earlier, the evaluation of the water temperature and air temperatures readings with the calibration values proved to be very good (Table 2). It can be observed that both parameters displayed diurnal fluctuations, and that the air temperature obviously varied a lot more than the water temperature. A mean of 17.0°C for the water temperature was calculated, and the range was between 9.0 and 27.2°C. The daily mean water temperature in fact could not be related to gross DO production, and it was only slightly related to the pH levels ($R = 0.42$, $R^2 = 0.17$, $P < 0.05$).

5.2 Mersey River

5.2.1 pH

The daily means and standard deviations of the AWQM pH data are presented in Table 7 to 13, accompanied by field and laboratory values. These values were also plotted, and are shown in Figures 36 to 42.

According to the monthly mean pH of the AWQM data (see Table 14), the pH in the Mersey River underwent a significant decrease from January to February, and from March to April ($P<0.05$, T-test). However, the two calibrations done on the AWQM took place during these periods. The first calibration was on January 22, when the pH was lowered by approximately 0.6 pH units, and the second one was on March 12, when the pH was lowered from 5.25 to 4.8 (Table 3). Those calibrations represent considerable breaks in the

usually gradual curves of the AWQM daily mean pH values (Figures 39 and 41), and result in the apparent pH decline.

Throughout the study period, the AWQM seemed to measure the acidity of the river approximately 0.2 pH units higher than the field values. Although the AWQM probe may have been drifting to higher pH values sometime after the calibration (see Figure 40), other factors may partially explain the differences in values. The field values were measured from samples taken at the surface of the river, where there was high flow and where the water was not completely ice covered. In addition, the field pH values were then read at room temperature, while the AWQM pH probe was situated at the bottom of the river under constant ice-cover. Therefore, it is possible that the field and AWQM values are not directly comparable due to differences in carbon dioxide equilibria and inhomogeneity of the river water mass. It should be noted that the AWQM and laboratory pH values agree rather well, which suggests that the field values may in fact be biased low.

The pH readings taken by the AWQM after the second calibration (March 12) will be considered in detail in a separate section, as this corresponds to the period of river response to snowmelt.

5.2.2 Specific Conductance, Water Temperature and Air Temperature

The other parameters measured hourly by the AWQM are specific conductance, water temperature and air temperature. Daily means

and standard deviations were calculated for these parameters, and they are presented monthly in Tables 7 to 13 and in Figures 43 to 48. Also, the monthly mean, median, maximum and minimum values of the specific conductance hourly data are summarized in Table 15.

The specific conductance of the river ranged from 18 in November to 52 μS/cm in February (Table 15). Figures 43 to 48 show that the AWQM was not subjected to any calibrations, even though calibration values were taken (Table 15). These values coincided well enough with the AWQM data that it was judged unnecessary to calibrate.

The conductivity varied with the water temperature, presumably in response to mixing with inflowing water masses of different temperatures and conductivities (see Figures 43 and 44). The conductivity may also be affected by the river discharge, since an increase in discharge can cause a dilution of the ions. This can be observed in Fig. 45, where a decrease in specific conductance on December 5 was accompanied by a peak in discharge (Figure 51a).

There appears to be formation of ice cover on December 9, since the water temperature then stabilizes at 0°C (Figure 45). Consequently, the AWQM specific conductance values stabilize with the exception of a rapid increase on January 29 (Figure 46). The discharge values were unavailable for that day but, according to data from previous years, there is a peak in the major ion concentrations, such as magnesium, sodium and chloride, during this

period, which would indeed increase the specific conductance (Howell, unpublished data). After this increase, the specific conductance stays in the vicinity of 38 μS/cm and on March 12, the calibration value was 34.0 μS/cm, while the AWQM value was 35.4 μS/cm.

No data were registered between March 19 to 23 and afterwards, the water temperature probe drifted very high, so that the temperature compensated conductivity values could not be calculated. Therefore, the effects of snowmelt water on the river's conductivity, which is known to decrease the specific conductance because of dilution (McNeely, et al., 1979), cannot be studied in this report.

5.2.3 Snowmelt Event

5.2.3.1 Snowpack and Discharge

In order to observe the snowmelt events, the snowpack depth and the discharge were plotted in Figures 49 to 55. No snowpack was measured in October and November, while in December, the snowpack height was measured starting December 8, but remained lower than 10 cm throughout the month (Fig. 55b). It can be noted that the first measurable snowpack corresponds very closely to the formation of the ice-cover on December 9 (Fig. 45). Afterwards, except for December 26, there was constantly a measurable snowpack in the area until April 6.

Decreases in snowpack depth can be identified between February 11 and March 1, where it went from 74 cm to 51 cm, and from March 21 (87 cm) to April 6 (0 cm) (Fig. 53 to 55). The first decrease in snowpack depth was mild and did not seem to affect the river pH (Fig. 40). It is apparent that a snow compaction rather than a melt took place, since the water content of the snow barely changed during the snowpack depth decrease (see Fig. 53). As this snowpack compaction was followed by a calibration on March 12, the reliability of the AWQM data during the first snowpack depth decrease is questionable.

Another snow compaction can be identified between March 17 and March 24. In Figure 54b, it is apparent that the water content was stable while the snowpack height decreased, but by March 31, the water content of the snow seemed to have decreased accordingly with the snow depth (Fig. 54b).

According to meteorological data (Table 16), the snowmelt started on March 21 in response to air temperatures above the freezing point on the two preceeding days. Thereafter, the temperature highs were well over 0°C (Figures 56 and 57), which caused a dramatic snowmelt.

Even though the snowmelt started on March 21, the river discharge did not respond instantly. In Figure 54a, a peak in the discharge can be observed on March 22, but it then lowers again.

This increase in river discharge is not due to the snowmelt runoff, but rather to a large precipitation event. Indeed, Fig. 58 shows that the precipitation depth was 35.2 mm on March 21, and was 24.2 mm on March 22.

Although the snow was completely melted by April 6, the river discharge did not reach a peak until April 7, when the daily mean discharge reached 63.6 m^3/s (Figure 55). By correcting the time lag period of one day between the snowpack and the river discharge, it was found that they were negatively correlated during the snowmelt ($R = -0.86$; $R^2 = 0.75$; $P < 0.05$).

5.2.3.2 Snowpack Chemistry

The snowpack chemistry was determined from grab samples taken at the CAPMoN site and was later analysed in the laboratory. The results are shown in Table 17.

Figure 58 displays the precipitation pH that was measured in the Kejimkujik National Park area during the winter of 1986-87. It can be observed that the pH of the precipitation varied within each month, but no significant variations existed between the months (ANOVA ONEWAY, $P < 0.05$). However, the snowpack pH decreased from 5.2 to 4.7 between February 3 and February 24 (Table 18). Therefore, the hydrogen ion became more concentrated in the snowpack (Fig. 59). Johannessen and Henricksen (1978) measured an increase of pollutants, including the hydrogen ion, in the snowpack

during the winter. Although our data seem to agree with their results, some other factors may explain this increase of hydrogen ion in the snowpack. Table 16 shows two precipitation events of 2 mm each on February 4 and 5, which had precipitation pH values lower than 4.0. Also, on February 10 and 11 there were major precipitation events (total of 23.8 mm), having precipitation pH values of 4.76 and 4.79 respectively. Consequently, the snowpack chemistry was probably affected by the addition of acidic precipitation during the first half of the month of February.

The snowpack pH increased again significantly ($P < 0.05$, t-test) between February 24 and March 24 from a low of 4.7 pH units reaching 5.3 pH units (Fig. 54a). This increase also coincides with important precipitation events. On March 2, a total of 27.8 mm of precipitation with a pH of 5.56 fell during the day, while 10.8 mm of precipitation with a pH of 4.86 occurred during March 3 (Table 17). For further details on meteorological events, see Table 17.

Since acid rain is known to be associated with sulphur dioxide and nitrogen oxides (Vermeulen, 1979), it is important to measure the nitrite-nitrate and the sulphate concentrations both in the snow and the river. In the snow, it appears that both the sulphate and the nitrite-nitrate anions varied with the hydrogen ion (Figure 59a-b). These relationships indicated that sulphate and nitrite-nitrate are the major ions associated with the increase in acidity.

5.2.3.3 River Chemistry

Hourly hydrogen ion concentrations were plotted for the snowmelt event, and are presented in Figures 60 to 63. Also, Figures 41 and 42 show the pH measurements taken by the AWQM (daily means), by the field meter and by the laboratory analysis.

The AWQM data demonstrate a decrease from a pH of 4.9 - 5.0 on March 31 to a low of 4.6 - 4.8 on April 7. The field values are lower during the same period, with the pH declining from approximately 4.8 to a pH of 4.4 (Figures 41 and 42). Again, the reason for such a difference between the field and AWQM could be because of the depth of the sampling, since the field values were taken at the surface, while the AWQM values were taken at the bottom of Mersey River. Jeffries, et al. (1979) observed that meltwater, with a temperature near 0°C, has a tendency to form an acidic surface layer on the lake and also on the outflow stream. Thus, it is possible that the Mersey River is more acidic on the surface than on the bottom, which may partially explain the differences between the field and the AWQM pH measurements. Yet, the laboratory and the AWQM pH data seem to agree very well. According to the laboratory analysis, the pH declined from a pH of 5.0 to a pH of 4.8 (Fig. 41 and 42) during the snowmelt event, and increased again starting April 10. The water samples used for the field and the laboratory pH measurements were taken from the same bottle, and therefore the hypothesis that the depth of the river

and the carbon dioxide equilibria affected the comparability of pH measurements must be questioned. Figure 64 shows that there is generally good agreement between field and laboratory pH measurements from other projects during this same period. This suggests that the field pH measurements of this study may indeed be biased low, and that the laboratory and AWQM values give a better reflection of the snowmelt pH depression.

The hydrogen ion concentration and the discharge both peak on the same day, as was observed by Jeffries, et al. (1979), and the snowpack was completely melted one day after those peaks (Fig. 55, 62 and 63). Linear regression analysis indicated that hydrogen concentration and river discharge were positively correlated ($R = 0.71$, $R^2 = 0.51$; $P < 0.05$). Also, by correcting the time lag of one day between the hydrogen ion peak and the complete melting of the snowpack, there was a strong negative correlation ($R = -0.80$, $R^2 = 0.64$; $P < 0.05$). This indicates that the melting of the snowpack was directly related to the hydrogen ion concentration in the river with a one day time lag.

This study shows that a pH depression of approximately 0.2 pH units occurred during the snowmelt, according to AWQM and laboratory results, while the field measurements recorded a 0.4 pH units decrease. Such a change in river pH during snowmelt has been observed in other regions. Henricksen and Wright (1977) measured a decrease of 0.4-0.5 pH units in a small lake in south-central Norway, while in central Ontario, a total of 21 streams monitored

during the snowmelt had an average pH depression of 0.58 pH units (range 0.2-1.3 pH units) (Jeffries, et al., 1979). In the Quebec Region, the pH of Lac Laflamme, averaging 6.4 pH units, was down to a pH of 5.8 during the snowmelt event (Papineau, 1986). These results indicate that the snowpack melt in the Kejimkujik National Park area does not seem to affect the pH of the Mersey River, as much as lakes and streams in other regions. However, given the large drainage area and water residence time of the Mersey River Basin, it is probable that a more dramatic response to snowmelt would be observed in smaller first order streams. It should be noted that the accumulation of a large snowpack is unusual in this part of Atlantic Canada, and thus the observed pH depression of the Mersey River probably represents a worst case scenario.

Finally, concentrations of DOC, nitrate-nitrite and sulphate were considered in order to determine which anions were associated with the increased river hydrogen ion concentrations. These results are shown in Table 18. The concentrations of hydrogen, nitrate-nitrite and sulphate ions are also shown in Figures 65 to 71. Fig. 71 indicates that there is no positive relationship between DOC and hydrogen ion concentration and thus the pH depression cannot be explained by increased natural organic acidity. This agrees with Kerekes et al. (1986), who observed that organic anion concentrations in Kejimkujik streams reached minimum levels during the high spring discharge period. The fact that the sulphate and nitrate-nitrite concentrations appeared to be related to the hydrogen ion concentrations in the snowpack, would suggest

that the Mersey River pH depressions are due to the input of strong mineral acids. From Figures 69 and 70, there are no apparent relationships between the hydrogen ion concentrations and either the sulphate or the nitrate-nitrite concentrations of the Mersey River. However, the observed pH depression only represents a .010 meq/L change in hydrogen ion concentration and thus given the extremely low concentrations of sulphate and particularly nitrate-nitrite, it is quite possible that the expected river response is masked by analytical errors.

6. SUMMARY AND CONCLUSIONS

Following the analysis of the data from these two experiments with AWQM's, some general observations can be made:

- the Enviro-Labs System was judged unreliable, and was thus discarded;

- the Montedoro-Whitney System will continue to be used, according to the results at both sites, except for the DO probe that has been dropped;

- from the experiment at the Big Presque Isle Stream, it was determined that the simultaneous use of various systems is not recommended because they tend to interfere with each other;

- glass sample bottles, instead of plastic bottles, should be used in the Manning Philips Autosampler to avoid biased low phosphorus levels;

- in order to obtain more information on the primary productivity at the Big Presque Isle Stream, chlorophyll levels should be measured periodically;

- more frequent probe maintenance and calibrations should be established for an AWQM in a highly productive stream such as the Big Presque Isle Stream;

- for the Mersey River, further understanding of the hydrological processes included in the snowmelt could be obtained with more frequent snow sampling and some meltwater sampling;

- at the Mersey River, a relatively small pH depression of 0.2 pH units occured during spring snowmelt, but a smaller first order stream should also be monitored to see if the pH depression would be more dramatic in a system with shorter water residence time.

All in all, both experiments with AWQM's proved to be useful, since some physical, chemical and biological processes occuring in aquatic systems were observed. However, the data from the Big Presque Isle Stream was less reliable, since many of the observations could only be made during the periods following the calibrations, and mostly with corrected values. The high productivity of the stream was still evident, because of high DO and pH diurnal fluctuations. On the other hand, the Mersey River data was much more accurate in representing the river chemistry changes during the spring snowmelt.

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Table 1: AWQM probes used for each parameter at the Big Presque Isle Stream during summer 1986 and at the Mersey River during winter 1986-87.

Parameter	Probes - Big Presque Isle Str.	Probes - Mersey River
DO	Montedoro-Whitney Enviro-Labs Weston Stack	N/A
pH	Montedoro-Whitney Enviro-Labs	Montedoro-Whitney
Sp. Cond.	Montedoro-Whitney Enviro-Labs	Montedoro-Whitney
Wat. T.	Montedoro-Whitney Enviro-Labs	Montedoro-Whitney
Air T.	Analog Devices AD 590 Temperature Transducer and Amplifier Circuit	Analog Devices AD 590 Temperature Transducer and Amplifier Circuit
PAR	LICOR model LI 190SB Quantum Sensor and Amplifier	N/A

TABLE 2: AWQM AND CALIBRATION VALUES IN THE BIG PRESQUE ISLE STREAM AT TRACEY MILLS DURING SUMMER 1986

0 DATE	1 DO WS MG/L	2 DO M MG/L	3 DO CAL MG/L	4 PH M	5 PH E	6 PH CAL	7 CD M US/CM	8 CD E US/CM	9 CD CAL US/CM	10 WT M C	11 WT CAL C	12 AT C
JUNE 11		12.78	11.1	7.15		8.25	322	358	280	14.6	14.5	15.7
JUNE 23	10.05	26.60	10.6	7.70	10.60	7.80	311	330	300	17.4	17.0	18.6
JULY 15	11.20	17.31	11.5	8.53	8.16	8.10	296	370	320	17.3	17.0	21.0
JULY 30	6.50	12.84	10.6	8.29	7.86	8.30	281	145	300	18.9	18.3	16.8
AUG 21	8.90	26.62	12.0	8.41	8.34	8.40		319	300	18.2	18.0	22.9
SEPT 11	8.90	29.46	10.8	7.94		7.80		302	310	12.8	12.5	13.5

0 DATE	13 AT CAL C
JUNE 11	
JUNE 23	
JULY 15	22.0
JULY 30	17.2
AUG 21	22.2
SEPT 11	15.5

TABLE 3: AWQM AND CALIBRATION VALUES OF PARAMETERS MEASURED IN THE MERSEY RIVER ABOVE MILL FALLS DURING WINTER 1986-87

0 DATE	1 PH CAL	2 PH AWQM	3 CD CAL US/CM	4 CD AWQM US/CM	5 WT CAL C	6 WT AWQM C
OCT 23	4.9	5.48	30	31.4	8.0	8.0
JAN 22	4.8	5.50	32	29.2	0.5	0.0
MAR 12	4.8	5.25	34	35.4	0.5	0.5

TABLE 4: AWQM DAILY INTEGRATED VALUES OF DO (GROSS AND NET), OF PH AND OF PAR, AND DAILY MEAN VALUES OF DISCHARGE, WATER TEMPERATURE AND NUTRIENTS FOR THE BIG PRESQUE ISLE STREAM BETWEEN MAY 1986 AND SEPTEMBER 1986

0 DATE	1 DO GR MG/L	2 DO NET MG/L	3 PAR	4 PH	5 DISCH M**3/S	6 T. PHOS (mg/l)	7 NOX-N MG/L	8 D.O.C. (mg/l)	9 WT CELS.	10 NDO/ GDO %
1 21-MAY-86					6.62	0.017				
2 22-MAY-86					7.26	0.007	0.84	3.50	11.80	
3 23-MAY-86			68.97		13.30	0.007	0.75	4.40	11.10	
4 24-MAY-86			103.45		31.40	0.008	0.60	7.60	10.28	
5 25-MAY-86			293.10		39.70	0.011	0.55	8.40	11.30	
6 26-MAY-86			405.17		23.60	0.008	0.52	7.30	12.41	
7 27-MAY-86					16.30	0.011	0.59	6.00	13.62	
8 28-MAY-86					15.90	0.018	0.61	5.50		
9 29-MAY-86					14.40	0.009	0.66	5.30		
10 30-MAY-86					12.50	0.011	0.68	4.10		
11 31-MAY-86			356.16		10.60	0.009	0.65	4.70	15.19	
12 01-JUN-86			145.45	0.30	10.30	0.009	0.77	4.00	13.00	
13 02-JUN-86			242.42	0.42	11.80	0.009	0.76	4.10	11.69	
14 03-JUN-86			393.94	0.44	9.97	0.010	0.73	4.10	11.79	
15 04-JUN-86			151.52	0.31	8.31	0.009	0.78	4.00	11.70	
16 05-JUN-86			290.91	0.28	7.59	0.010	0.87	3.70	13.28	
17 06-JUN-86			371.21	0.30	6.72	0.009	0.87	3.40	14.70	
18 07-JUN-86			386.36	0.25	6.06	0.010	0.87	3.40	15.95	
19 08-JUN-86			113.64	0.23	7.24	0.013	0.89	3.20	15.17	
20 09-JUN-86			280.30	0.30	9.39	0.010	0.80	3.80	14.75	
21 10-JUN-86			325.76	0.43	7.32	0.012	0.72	4.30	14.74	
22 11-JUN-86			195.31		6.31	0.014	0.75	4.40	15.41	
23 12-JUN-86					5.57	0.017	0.75	4.00	12.97	
24 13-JUN-86			125.00		5.31	0.016	0.97	3.70	13.08	
25 14-JUN-86					5.30	0.017	1.00	3.50		
26 15-JUN-86			375.00		5.23	0.015	0.94	3.50	17.13	
27 16-JUN-86			201.49	0.33	4.54	0.021	0.99	3.50	16.66	
28 17-JUN-86			305.97	0.31	4.52	0.020	1.00	3.80	16.81	
29 18-JUN-86			350.75	0.29	3.93	0.020	0.99	3.80	14.88	
30 19-JUN-86					3.71	0.022	0.94	3.20	15.26	
31 20-JUN-86			350.75	0.29	3.71	0.014	0.92	3.40	16.97	
32 21-JUN-86			333.33	0.31	3.48	0.013	0.86	3.50	18.78	
33 22-JUN-86			246.03	0.33	3.00	0.010	0.74	3.80	19.46	
34 23-JUN-86					2.78	0.025	0.77	3.20	22.26	
35 24-JUN-86				0.58	2.69	0.013	0.79	3.50	21.15	
36 25-JUN-86			246.03		2.61	0.013	0.79	3.60	18.21	
37 26-JUN-86					2.31	0.022	0.70	3.30		
38 27-JUN-86	1.55	0.53	210.00		2.04	0.015	0.75	3.50	15.64	25.21
39 28-JUN-86	1.24	0.49	135.00		2.70	0.014	0.86	3.20	16.74	36.31
40 29-JUN-86					2.89	0.015	0.82	3.20	19.17	
41 30-JUN-86					2.49	0.015	0.79	3.30		
42 01-JUL-86	2.07	0.90	352.94	0.40	2.30	0.030	0.74	3.80	19.76	25.63
43 02-JUL-86	1.83	0.60	198.53		2.11	0.027	0.78	3.50	18.15	29.98
44 03-JUL-86					1.90	0.027	0.76	3.60	19.75	
45 04-JUL-86	1.93	0.38	294.12	0.41	1.86	0.030	0.76	3.60	19.88	12.95
46 05-JUL-86	1.26	0.10	183.82	0.26	2.39	0.025	1.20	2.90	18.98	5.18
47 06-JUL-86	1.86	0.26	277.78	0.32	2.35	0.029	1.10	3.00	18.45	9.36
48 07-JUL-86	1.46	0.00	63.49	0.22	2.19	0.034			16.90	0.00
49 08-JUL-86	1.60	0.38	309.52	0.31	2.19				19.67	12.28
50 09-JUL-86	1.66	0.24	293.65	0.30	1.94				20.47	8.17

TABLE 4: AWQM DAILY INTEGRATED VALUES OF DO (GROSS AND NET), OF PH AND OF PAR, AND DAILY MEAN VALUES OF DISCHARGE, WATER TEMPERATURE AND NUTRIENTS FOR THE BIG PRESQUE ISLE STREAM BETWEEN MAY 1986 AND SEPTEMBER 1986

0 DATE	1 DO GR MG/L	2 DO NET MG/L	3 PAR	4 PH	5 DISCH M**3/S	6 T. PHOS (mg/l)	7 NOX-N MG/L	8 D.O.C. (mg/l)	9 WT CELS.	10 NDO/ GDO %
51 10-JUL-86	1.68	0.06	285.71	0.32	1.82				17.47	2.10
52 11-JUL-86	1.83	0.14	264.71	0.29	1.73				17.43	5.25
53 12-JUL-86	1.69	0.03	264.71		1.57				18.48	1.05
54 13-JUL-86	1.58	0.00	276.47		1.57				20.19	0.00
55 14-JUL-86	1.53	0.33	47.06	0.19	1.88				17.52	70.83
56 15-JUL-86	1.44	0.75	223.53	0.26	3.30				16.96	33.55
57 16-JUL-86	2.18	1.25	333.33	0.34	3.61				19.51	37.50
58 17-JUL-86	1.85	0.78	304.35	0.35	2.45	0.016	0.81	4.40	21.19	25.46
59 18-JUL-86					2.37	0.019	0.91	3.40	19.93	
60 19-JUL-86					2.42	0.022	0.81	3.60		
61 20-JUL-86					2.27	0.017	0.82	3.40	23.20	
62 21-JUL-86	1.32	0.35	335.94		1.93	0.021	0.75	3.80	23.70	10.51
63 22-JUL-86	1.56	0.09		0.36	1.59	0.021	0.43	4.90	22.02	
64 23-JUL-86	1.50	0.00		0.35	1.22	0.019	0.63	3.50	22.37	
65 24-JUL-86	1.59	0.00	328.13	0.38	0.95	0.026	0.60	4.10	21.73	0.00
66 25-JUL-86					0.76	0.029	0.58	3.10		
67 26-JUL-86					1.10	0.025	0.40	3.60		
68 27-JUL-86					2.57	0.037	0.58	4.10	23.55	
69 28-JUL-86	0.83	0.05	214.81	0.41	1.77	0.046	0.55	4.30	21.68	2.27
70 29-JUL-86	1.07	0.12	251.85	0.41	1.28	0.053	0.38	4.20	21.18	4.84
71 30-JUL-86	1.02	0.29	103.70	0.46	0.97	0.058	0.32	4.10	19.09	28.22
72 31-JUL-86				0.20	2.19	0.036	0.59	3.60	16.27	
73 01-AUG-86					6.91	0.050	0.67	5.70		
74 02-AUG-86					4.53	0.034	0.69	6.80		
75 03-AUG-86					3.19	0.017	0.62	7.10	17.88	
76 04-AUG-86	1.28	0.19	270.59	0.50	2.80	0.040	0.70	6.70	20.42	7.19
77 05-AUG-86	1.78	0.03	276.47	0.50	2.29	0.019	0.52	6.10	20.65	1.00
78 06-AUG-86	1.55	0.03	261.11		1.86	0.017	0.51	5.70	21.87	1.32
79 07-AUG-86					1.61	0.017	0.45	5.10	21.34	
80 08-AUG-86					3.88	0.013	0.54	4.80	19.91	
81 09-AUG-86					10.70	0.022	0.54	8.70		
82 10-AUG-86					7.57	0.025	0.47	11.00		
83 11-AUG-86				0.16	4.96	0.022	0.34	10.00	18.22	
84 12-AUG-86	1.56	0.03	150.68	0.41	4.13	0.014	0.49	9.20	17.72	2.07
85 13-AUG-86	2.03	0.56	150.68	0.41	3.25	0.012	0.43	8.10	18.39	37.33
86 14-AUG-86	2.81	1.28	273.97	0.50	2.81	0.010	0.44	8.10	19.23	46.77
87 15-AUG-86	2.41	1.13	191.78	0.51	2.80	0.012	0.40	6.70	19.58	58.66
88 16-AUG-86	1.18	0.13	47.76	0.26	2.77	0.011	0.41	6.40	18.54	26.84
89 17-AUG-86	2.18	1.28	158.21	0.53	2.77	0.011	0.51	6.50	19.17	81.04
90 18-AUG-86	1.67	0.51	86.57		2.29	0.012	0.49	7.40	16.48	59.24
91 19-AUG-86	2.05	0.72	205.97		2.45				19.41	34.86
92 20-AUG-86	2.05	0.64	176.12	0.47	2.48	0.015	0.55	7.80	18.95	36.40
93 21-AUG-86					2.16	0.051	0.48	6.00		
94 22-AUG-86	2.46	1.51	269.23	0.53	2.18	0.010	0.37	4.90	20.54	56.22
95 23-AUG-86	2.30	0.81	323.08	0.45	1.94	0.004	0.26	6.90	17.78	25.10
96 24-AUG-86	1.22	0.08	53.85	0.15	8.18	0.008	0.36	7.60	15.38	15.06
97 25-AUG-86	1.27	0.11	100.00	0.10	16.80	0.011	0.46	8.00	13.39	10.81
98 26-AUG-86	1.47	0.53	179.69	0.22	9.77	0.100	0.53	13.00	15.56	29.60
99 27-AUG-86	0.74	0.00	328.13	0.07	6.54	0.019	0.60	10.00	13.82	0.00
100 28-AUG-86	1.06	0.19	328.13	0.24	6.10	0.018	0.69	8.60	13.61	5.84

TABLE 4: AWQM DAILY INTEGRATED VALUES OF DO (GROSS AND NET), OF PH AND OF PAR, AND DAILY MEAN VALUES OF DISCHARGE, WATER TEMPERATURE AND NUTRIENTS FOR THE BIG PRESQUE ISLE STREAM BETWEEN MAY 1986 AND SEPTEMBER 1986

0 DATE	1 DO GR MG/L	2 DO NET MG/L	3 PAR	4 PH	5 DISCH M**3/S	6 T. PHOS (mg/l)	7 NOX-N MG/L	8 D.O.C. (mg/l)	9 WT CELS.	10 NDO/ GDO %
101 29-AUG-86	1.40	0.34		0.25	4.97	0.014	0.58	9.20	10.93	
102 30-AUG-86	1.49	0.34	240.74	0.23	3.95	0.009	1.10	5.40	12.14	14.14
103 31-AUG-86					3.42	0.052	0.64	4.70	14.08	
104 01-SEP-86					3.06	0.015	0.58	6.30	15.79	
105 02-SEP-86	1.39	0.16	179.69	0.35	2.85	0.011	0.71	5.70	14.57	8.85
106 03-SEP-86	1.43	0.48	328.13	0.47	2.76	0.013		9.90	16.10	14.55
107 04-SEP-86	1.75	0.39	328.13		2.48				14.65	11.77
108 05-SEP-86					2.21					
109 06-SEP-86					2.64					
110 07-SEP-86				0.39	2.83				14.75	
111 08-SEP-86	1.64	0.08	266.67	0.37	2.58				12.88	2.88
112 09-SEP-86	1.67	0.33	251.85	0.31	2.36				12.25	13.24
113 10-SEP-86	1.79	0.46	251.85	0.37	2.26				12.68	18.33
114 11-SEP-86					2.85					
115							0.68			
116 MEAN	1.60	0.40	238.61	0.60	5.47	0.020		5.26	17.05	20.53

TABLE 5: BASIC STATISTICS ON CORRECTED VALUES OF PARAMETERS MEASURED BY THE AWQM AT THE BIG PRESQUE ISLE STREAM AT TRACEY MILLS FROM MAY 1986 TO SEPTEMBER 1986

0	1 CORR DO MG/L	2 CORR PH M	3 COND E US/CM	4 WT M CELS.
COUNT	1416.00	2083.00	2071.00	2057.00
SUM	11941.83	16346.42	615047.00	34898.10
MEAN	8.43	7.85	296.98	16.97
ST.DEV.	1.76	0.55	51.50	3.85
MAXIM.	13.22	9.74	461.00	27.20
MINIM.	2.70	4.57	132.00	9.00
RANGE	10.53	5.17	329.00	18.20

TABLE 6: TIME OF DAILY PEAKS FOR DO, PH AND PAR FROM AWQM DATA AT THE BIG PRESQUE ISLE STREAM AT TRACEY MILLS FROM JULY 1986 TO SEPTEMBER 1986

0 DATE	1 TIME OF DO PEAK	2 TIME OF PH PEAK	3 TIME OF PAR PEAK	0 DATE	1 TIME OF DO PEAK	2 TIME OF PH PEAK	3 TIME OF PAR PEAK
01-JUL-86	1300	1700	1300	17-AUG-86	1400	1700	1300
02-JUL-86	1300	1800	1300	18-AUG-86	1500	1800	1400
03-JUL-86				19-AUG-86			
04-JUL-86	1200	1700	1100	20-AUG-86	1500	1700	1400
05-JUL-86	1500	1800	1400	21-AUG-86			
06-JUL-86	1400	1700	1300	22-AUG-86	1500	1700	1400
07-JUL-86	1700	1800	1400	23-AUG-86	1500	1700	1300
08-JUL-86	1200	1800	1200	24-AUG-86	1300	1400	1400
09-JUL-86	1400	1900		25-AUG-86	1400	1600	1400
10-JUL-86	1300	1800	1100	26-AUG-86	1200	1500	1200
11-JUL-86	1400	1700	1200	27-AUG-86			
12-JUL-86				28-AUG-86	1400	1900	1400
13-JUL-86				29-AUG-86			
14-JUL-86	1500	1700	1200	30-AUG-86	1400	1800	1200
15-JUL-86	1300	1900	1300	31-AUG-86	1200	1900	1400
16-JUL-86	1300	1800	1300	01-SEP-86			
17-JUL-86	1200	1700	1200	02-SEP-86			
18-JUL-86				03-SEP-86	1300	1700	1300
19-JUL-86				04-SEP-86	1300	1800	1300
20-JUL-86	1400	1700	1300	05-SEP-86			
21-JUL-86	1400	1700	1200	06-SEP-86			
22-JUL-86	1300	1700	1300	07-SEP-86			
23-JUL-86	1600	1900	1300	08-SEP-86			
24-JUL-86	1300	1900	1200	09-SEP-86	1200	1800	1200
25-JUL-86				10-SEP-86	1400	1800	1200
26-JUL-86				MEAN	1340	1730	1300
27-JUL-86							
28-JUL-86							
29-JUL-86	1400	1700	1300				
30-JUL-86	1400	1800	1300				
31-JUL-86							
01-AUG-86							
02-AUG-86							
03-AUG-86	1600	1900	1700				
04-AUG-86	1200	1800	1400				
05-AUG-86	1300	1600	1200				
06-AUG-86	1300	1800	1300				
07-AUG-86							
08-AUG-86	1400	1700	1300				
09-AUG-86							
10-AUG-86							
11-AUG-86							
12-AUG-86							
13-AUG-86							
14-AUG-86	1300	1800	1400				
15-AUG-86							
16-AUG-86	1400	1700	1300				

TABLE 7: DAILY MEAN VALUES AND STANDARD DEVIATIONS OF PARAMETERS MEASURED WITH THE AWQM AT THE MERSEY RIVER ABOVE MILL FALLS DURING OCTOBER 1986

0 DATE	1 pH MEAN	2 PH L.S.D.	3 PH H.S.D.	4 CD MEAN US/CM	5 CD @25 US/CM	6 CD @25 LSD US/CM	7 CD @25 HSD US/CM	8 WT C MEAN	9 WT C L.S.D.	10 WT C H.S.D.
23-OCT-86	5.10	5.09	5.11	21.62	30.76	29.13	32.40	8.91	8.73	9.08
24-OCT-86	5.04	5.03	5.06	22.43	32.04	30.14	33.94	8.79	8.58	8.99
25-OCT-86										
26-OCT-86	5.10	5.09	5.12	22.10	32.26	30.34	34.17	8.01	7.84	8.18
27-OCT-86	5.08	5.06	5.11	21.73	31.89	30.07	33.71	7.81	7.65	7.97
28-OCT-86	5.11	5.09	5.13	21.58	31.01	29.15	32.86	8.57	8.38	8.77
29-OCT-86	5.15	5.13	5.16	21.53	30.76	28.90	32.62	8.78	8.58	8.99
30-OCT-86	5.16	5.13	5.18	22.17	31.43	29.48	33.38	9.04	8.88	9.21
31-OCT-86	5.23	5.21	5.24	21.95	32.35	30.44	34.25	7.66	7.50	7.82

0 DATE	11 AT C MEAN	12 AT C L.S.D.	13 AT C H.S.D.	14 H+ MEAN MEQ/L	15 H+ HSD MEQ/L	16 H+ LSD MEQ/L
23-OCT-86	13.13	13.06	13.208	0.009	0.008	0.008
24-OCT-86	9.65	9.58	9.713	0.009	0.009	0.009
25-OCT-86						
26-OCT-86	12.17	12.09	12.244	0.008	0.008	0.008
27-OCT-86	9.48	9.40	9.552	0.008	0.009	0.008
28-OCT-86	11.74	11.66	11.828	0.008	0.008	0.007
29-OCT-86	12.42	11.93	12.904	0.007	0.007	0.007
30-OCT-86	12.31	12.24	12.383	0.007	0.007	0.007
31-OCT-86	8.19	8.11	8.257	0.006	0.006	0.006

TABLE 8: DAILY MEAN VALUES AND STANDARD DEVIATIONS OF PARAMETERS MEASURED WITH THE AWQM AT THE MERSEY RIVER ABOVE MILL FALLS DURING NOVEMBER 1986

0 DATE	1 pH MEAN	2 PH L.S.D.	3 PH H.S.D.	4 CD MEAN US/CM	5 CD @25 US/CM	6 CD @25 LSD US/CM	7 CD @25 HSD US/CM	8 WT C MEAN	9 WT C L.S.D.	10 WT C H.S.D.	11 AT C MEAN
01-NOV-86	5.26	5.24	5.27	20.83	31.77	29.76	33.79	6.80	6.63	6.98	8.82
02-NOV-86	5.24	5.23	5.26	22.88	33.51	31.53	35.49	7.88	7.72	8.04	12.23
03-NOV-86	5.27	5.25	5.29	21.55	32.49	30.37	34.61	6.80	6.63	6.96	6.22
04-NOV-86	5.27	5.25	5.29	18.41	28.43	26.37	30.48	5.90	5.72	6.08	6.32
05-NOV-86	5.35	5.33	5.37	14.82	23.63	21.36	25.89	5.01	4.82	5.20	5.90
06-NOV-86	5.28	5.27	5.30	12.55	20.23	18.15	22.30	4.19	4.03	4.35	4.24
07-NOV-86											
08-NOV-86	5.36	5.34	5.38	13.08	20.86	19.03	22.69	4.61	4.45	4.76	7.74
09-NOV-86	5.30	5.28	5.32	19.51	29.73	27.70	31.77	6.30	6.12	6.48	14.68
10-NOV-86	5.31	5.30	5.33	20.92	31.73	29.42	34.04	6.56	6.39	6.74	7.97
11-NOV-86	5.36	5.34	5.38	13.97	22.29	20.50	24.08	4.60	4.42	4.78	5.63
12-NOV-86	5.34	5.33	5.36	13.63	21.80	19.90	23.70	4.49	4.31	4.68	5.75
13-NOV-86	5.32	5.31	5.33	13.74	22.05	20.09	24.00	4.37	4.25	4.50	6.33
14-NOV-86	5.35	5.33	5.37	13.52	22.49	20.68	24.30	2.96	2.77	3.14	1.25
15-NOV-86	5.31	5.29	5.33	14.45	24.88	22.96	26.81	1.46	1.28	1.63	3.94
16-NOV-86	5.30	5.28	5.31	13.88	23.41	21.46	25.36	2.32	2.15	2.49	5.83
17-NOV-86	5.27	5.25	5.29	13.73	23.08	21.18	24.97	2.49	2.33	2.65	6.66
18-NOV-86	5.25	5.19	5.31	13.58	22.72	20.81	24.63	2.69	2.49	2.86	7.59
19-NOV-86	5.24	5.18	5.31	13.82	23.20	21.31	25.09	2.53	2.36	2.70	4.50
20-NOV-86	5.29	5.28	5.31	14.93	26.42	24.35	28.49	0.26	0.10	0.43	3.88
21-NOV-86	5.29	5.28	5.31	14.61	25.66	23.71	27.61	0.60	0.43	0.78	4.10
22-NOV-86	5.25	5.24	5.27	13.97	24.11	22.30	25.93	1.34	1.19	1.49	7.08
23-NOV-86	5.31	5.30	5.33	15.71	27.66	25.46	29.86	0.48	0.33	0.64	3.07
24-NOV-86	5.28	5.27	5.30	15.52	27.27	25.30	29.25	0.56	0.38	0.74	3.59
25-NOV-86	5.25	5.23	5.27	14.00	24.21	22.34	26.07	1.28	1.10	1.45	6.90
26-NOV-86	5.27	5.26	5.29	14.35	24.77	22.76	26.78	1.36	1.18	1.53	4.24
27-NOV-86	5.22	5.20	5.24	13.87	23.55	21.71	25.39	2.06	1.89	2.23	9.42
28-NOV-86	5.22	5.20	5.24	13.67	22.97	20.96	24.98	2.51	2.33	2.69	5.57
29-NOV-86	5.18	5.16	5.20	13.70	23.17	21.31	25.02	2.23	2.05	2.40	5.80
30-NOV-86	5.14	5.12	5.16	13.56	22.96	21.04	24.87	2.18	2.02	2.33	5.76
30-NOV-86	5.16	5.14	5.18	14.32	24.61	22.40	26.82	1.54	1.36	1.72	2.24

TABLE 8: DAILY MEAN VALUES AND STANDARD DEVIATIONS OF PARAMETERS MEASURED WITH THE AWQM AT THE MERSEY RIVER ABOVE MILL FALLS DURING NOVEMBER 1986

0 DATE	12 AT C L.S.D.	13 AT C H.S.D.	14 FIELD PH	15 LAB PH	16 CD LAB US/CM	17 H+ MEAN US/CM	18 H+ FLD MEQ/L	19 H+ LAB MEQ/L	20 H+ HSD MEQ/L	21 H+ LSD MEQ/L
01-NOV-86	8.76	8.89				0.0055			0.0057	0.0054
02-NOV-86	12.15	12.30				0.0057			0.0059	0.0055
03-NOV-86	6.13	6.31	5.16	5.10	31.60	0.0054	0.0069	0.0079	0.0056	0.0052
04-NOV-86	6.24	6.40				0.0054			0.0056	0.0051
05-NOV-86	5.84	5.96				0.0045			0.0047	0.0043
06-NOV-86	4.17	4.30				0.0052			0.0054	0.0050
07-NOV-86										
08-NOV-86						0.0044			0.0046	0.0042
09-NOV-86						0.0050			0.0053	0.0048
10-NOV-86			4.86	5.10	31.60	0.0049	0.0138	0.0079	0.0051	0.0047
11-NOV-86						0.0044			0.0045	0.0042
12-NOV-86						0.0046			0.0047	0.0044
13-NOV-86						0.0048			0.0049	0.0046
14-NOV-86						0.0045			0.0047	0.0043
15-NOV-86						0.0049			0.0052	0.0047
16-NOV-86						0.0051			0.0052	0.0049
17-NOV-86			5.06	5.10	31.40	0.0053	0.0087	0.0079	0.0056	0.0051
18-NOV-86						0.0059			0.0065	0.0049
19-NOV-86						0.0060			0.0067	0.0049
20-NOV-86						0.0051			0.0053	0.0049
21-NOV-86						0.0051			0.0053	0.0049
22-NOV-86						0.0056			0.0058	0.0053
23-NOV-86						0.0049			0.0051	0.0047
24-NOV-86			5.06	5.10	30.00	0.0052	0.0087	0.0079	0.0054	0.0051
25-NOV-86						0.0056			0.0059	0.0054
26-NOV-86						0.0053			0.0055	0.0052
27-NOV-86						0.0061			0.0063	0.0058
28-NOV-86						0.0060			0.0063	0.0057
29-NOV-86						0.0066			0.0069	0.0063
30-NOV-86						0.0073			0.0077	0.0070
30-NOV-86	0.93	1.13				0.0070			0.0073	0.0066

TABLE 9: DAILY MEAN VALUES AND STANDARD DEVIATIONS OF PARAMETERS MEASURED WITH THE AWQM AT THE MERSEY RIVER ABOVE MILL FALLS DURING DECEMBER 1986

0 DATE	1 pH MEAN	2 PH L.S.D.	3 PH H.S.D.	4 CD MEAN US/CM	5 CD @25 US/CM	6 CD @25 LSD US/CM	7 CD @25 HSD US/CM	8 WT C MEAN	9 WT C L.S.D.	10 WT C H.S.D.	11 AT C MEAN
01-DEC-86	5.18	5.16	5.20	16.10	28.17	25.85	30.50	0.76	0.61	0.91	1.92
02-DEC-86	5.19	5.18	5.20	16.61	29.35	26.65	32.04	0.32	0.16	0.49	3.11
03-DEC-86	5.16	5.15	5.18	15.58	27.38	25.18	29.59	0.60	0.45	0.75	6.52
04-DEC-86	5.17	5.15	5.19	14.08	24.06	22.01	26.11	1.99	1.80	2.18	8.19
05-DEC-86	5.18	5.17	5.19	13.63	23.18	21.24	25.11	2.00	1.87	2.13	6.33
06-DEC-86											
07-DEC-86											
08-DEC-86	5.16	5.14	5.18	17.44	30.96	28.54	33.37	0.13	0.03	0.22	0.48
09-DEC-86	5.15	5.14	5.17	17.20	30.62	28.74	32.50	0.00	0.00	0.00	-1.59
10-DEC-86	5.13	5.11	5.16	17.12	30.48	28.52	32.44	0.00	0.00	0.00	5.10
11-DEC-86	5.17	5.16	5.19	17.45	31.05	28.91	33.19	0.02	-0.02	0.05	3.77
12-DEC-86	5.17	5.15	5.18	17.93	31.87	29.39	34.34	0.06	-0.02	0.14	4.64
13-DEC-86	5.20	5.19	5.21	17.23	30.68	28.56	32.79	0.00	-0.03	0.03	3.55
14-DEC-86	5.24	5.24	5.25	18.60	33.11	31.31	34.91	0.00	0.00	0.00	4.10
15-DEC-86	5.23	5.21	5.25	17.28	30.75	28.80	32.70	0.00	-4e-03	4.17e-03	4.00
16-DEC-86	5.25	5.23	5.27	16.94	30.15	28.34	31.97	4.17e-03	0.00	8.33e-03	3.74
17-DEC-86	5.29	5.26	5.31	17.27	30.75	28.77	32.72	0.00	-0.03	0.03	2.14
18-DEC-86	5.27	5.25	5.30	17.24	30.69	28.68	32.70	0.00	-4e-03	4.17e-03	1.50
19-DEC-86	5.26	5.27	5.31	17.13	30.49	28.54	32.44	0.00	0.00	0.00	2.86
20-DEC-86	5.26			17.05	30.35	28.50	32.20	0.00	0.00	0.00	4.43
21-DEC-86	5.30			17.73	31.54	29.27	33.82	0.01	-0.01	0.04	4.15
22-DEC-86	5.31			17.30	30.80	28.74	32.86	4.17e-03	-0.03	0.04	0.86
23-DEC-86	5.30			17.32	30.82	28.92	32.71	8.33e-03	-4e-03	0.02	2.04
24-DEC-86	5.31			17.60	31.33	29.48	33.18	0.00	-6e-03	6.25e-03	4.39
25-DEC-86											
26-DEC-86	5.29			17.33	30.75	28.87	32.63	0.14	-0.01	0.29	8.92
27-DEC-86	5.34			17.54	31.14	29.29	32.99	0.10	-0.05	0.26	5.61
28-DEC-86	5.35			17.29	30.72	29.06	32.37	0.09	0.00	0.18	2.69
29-DEC-86											
30-DEC-86	5.32			17.40	30.87	29.12	32.62	0.15	0.00	0.30	5.75
31-DEC-86	5.26			17.32	30.74	28.87	32.62	0.12	9.09e-03	0.23	3.88

TABLE 9: DAILY MEAN VALUES AND STANDARD DEVIATIONS OF PARAMETERS MEASURED WITH THE AWQM AT THE MERSEY RIVER ABOVE MILL FALLS DURING DECEMBER 1986

0 DATE	12 AT C L.S.D.	13 AT C H.S.D.	14 pH FIELD	15 pH LAB	16 CD LAB US/CM	17 H+ MEAN MEQ/L	18 H+ FLD MEQ/L	19 H+ LAB MEQ/L	20 H+ MEQ/L H.S.D.	21 H+ MEQ/L L.S.D.
01-DEC-86	1.84	2.00	4.74	5.03	32.2	0.0066	0.0182	0.0093	0.0069	0.0063
02-DEC-86	3.04	3.18				0.0065			0.0067	0.0063
03-DEC-86	6.48	6.57				0.0069			0.0071	0.0066
04-DEC-86	8.12	8.26				0.0067			0.0070	0.0064
05-DEC-86	6.27	6.40				0.0067			0.0068	0.0064
06-DEC-86										
07-DEC-86										
08-DEC-86	0.37	0.59	4.70	4.84	32.4	0.0069	0.0200	0.0145	0.0072	0.0066
09-DEC-86	-1.70	-1.47				0.0071			0.0073	0.0068
10-DEC-86	5.04	5.17				0.0074			0.0078	0.0070
11-DEC-86	3.70	3.84				0.0068			0.0070	0.0065
12-DEC-86	4.58	4.70				0.0068			0.0071	0.0065
13-DEC-86	3.45	3.65				0.0064			0.0065	0.0062
14-DEC-86	4.00	4.20				0.0058			0.0058	0.0057
15-DEC-86	3.94	4.05	4.85	4.87	33.9	0.0059	0.0141	0.0135	0.0062	0.0057
16-DEC-86	3.65	3.83				0.0056			0.0058	0.0053
17-DEC-86	2.05	2.23				0.0052			0.0054	0.0049
18-DEC-86	1.19	1.80				0.0054			0.0057	0.0051
19-DEC-86	2.80	2.92				0.0055			0.0053	0.0049
20-DEC-86	4.33	4.53				0.0056				
21-DEC-86	4.06	4.24				0.0051				
22-DEC-86	0.66	1.05	4.78	4.87	34.3	0.0050	0.0166	0.0135		
23-DEC-86	1.98	2.10				0.0050				
24-DEC-86	4.31	4.47				0.0049				
25-DEC-86										
26-DEC-86	8.84	9.00				0.0051				
27-DEC-86	5.54	5.69				0.0046				
28-DEC-86	2.61	2.77				0.0045				
29-DEC-86			4.82	4.90	33.8		0.0151	0.0126		
30-DEC-86	5.70	5.80				0.0048				
31-DEC-86	3.79	3.97				0.0057				

TABLE 10: DAILY MEAN VALUES AND STANDARD DEVIATIONS OF PARAMETERS MEASURED WITH THE AWQM AT THE MERSEY RIVER ABOVE MILL FALLS DURING JANUARY 1987

0 DATE	1 pH MEAN	2 PH L.S.D.	3 PH H.S.D.	4 COND US/CM	5 COND @25 US/CM	6 CD @25 LSD US/CM	7 CD @25 HSD US/CM	8 WT C MEAN	9 WT C L.S.D.	10 WT C H.S.D.	11 AT C MEAN
01-JAN-87	5.32	5.31	5.34	17.33	30.85	28.98	32.72	0.005	-0.029	0.038	2.80
02-JAN-87	5.30	5.29	5.31	17.60	31.33	29.48	32.94	0.000	0.000	0.000	1.17
03-JAN-87											
04-JAN-87	5.33	5.31	5.35	17.56	31.26	29.39	33.12	0.113	0.000	0.227	2.23
05-JAN-87	5.35	5.33	5.37	17.73	31.57	29.76	33.37	0.058	-0.008	0.125	2.49
06-JAN-87	5.34	5.33	5.36	17.34	30.87	29.06	32.69	0.011	-0.028	0.050	3.25
07-JAN-87	5.33	5.31	5.34	17.22	30.65	28.79	32.50	0.092	-0.025	0.208	5.00
08-JAN-87	5.34	5.32	5.35	17.06	30.36	28.53	32.19	0.150	-0.025	0.325	3.35
09-JAN-87	5.35	5.33	5.37	17.51	31.17	29.43	32.91	0.089	-0.028	0.206	1.73
10-JAN-87	5.37	5.36	5.39	17.39	30.96	29.08	32.83	0.000	-0.010	0.010	0.90
11-JAN-87	5.34	5.32	5.36	17.78	31.64	29.76	33.51	0.000	0.000	0.000	3.41
12-JAN-87	5.43	5.39	5.48	17.47	31.09	29.25	32.93	0.000	0.000	0.000	1.43
13-JAN-87	5.44	5.38	5.50	17.61	31.35	29.47	33.24	0.000	0.000	0.000	0.94
14-JAN-87											
15-JAN-87	5.43	5.40	5.45	17.55	31.25	29.33	32.97	0.000	-0.014	0.014	3.99
16-JAN-87	5.42	5.40	5.44	17.47	31.09	29.22	32.97	0.000	-0.029	0.029	5.45
17-JAN-87	5.45	5.43	5.47	17.58	31.28	29.43	33.13	0.000	-0.038	0.038	-0.34
18-JAN-87	5.46	5.44	5.48	17.80	31.68	29.62	33.75	0.000	-0.050	0.050	-0.74
19-JAN-87	5.42	5.40	5.44	18.01	32.06	30.27	33.85	0.000	-0.033	0.033	2.22
20-JAN-87	5.43	5.42	5.45	17.58	31.28	29.43	33.13	0.008	-0.025	0.042	4.68
21-JAN-87	5.45	5.44	5.48	17.89	31.84	29.98	33.69	0.000	-0.067	0.067	3.11
22-JAN-87	5.36	5.35	5.38	17.75	31.60	29.49	33.24	0.000	-0.086	0.086	-8.06
23-JAN-87	4.80	4.78	4.82	17.71	31.52	29.65	33.39	0.025	-0.075	0.125	5.07
24-JAN-87	4.83	4.80	4.85	17.44	31.05	29.33	32.77	0.025	-0.071	0.129	2.19
25-JAN-87	4.88	4.86	4.90	17.38	30.94	29.12	32.76	0.028	-0.072	0.128	-9.02
26-JAN-87	4.86	4.84	4.88	17.57	31.28	29.59	32.96	0.042	-0.042	0.125	-11.88
27-JAN-87	4.87	4.85	4.88	18.12	32.26	30.16	34.36	0.019	-0.081	0.119	-9.10
28-JAN-87	4.90	4.88	4.92	17.62	31.37	29.47	33.26	0.022	-0.056	0.100	-8.31
29-JAN-87	4.94	4.91	4.95	17.59	31.31	29.53	33.10	0.038	-0.062	0.138	-11.76
30-JAN-87	4.94	4.92	4.96	21.54	38.35	36.49	40.20	0.031	-0.063	0.125	-10.93
31-JAN-87											

TABLE 10: DAILY MEAN VALUES AND STANDARD DEVIATIONS OF PARAMETERS MEASURED WITH THE AWQM AT THE MERSEY RIVER ABOVE MILL FALLS DURING JANUARY 1987

0 DATE	12 AT C L.S.D.	13 AT C H.S.D.	14 pH FIELD	15 H+ MEQ/L MEAN	16 H+ FLD MEQ/L	17 H+ MEQ/L H.S.D.	18 H+ MEQ/L L.S.D.
01-JAN-87	2.72	2.88		0.0048		0.0050	0.0046
02-JAN-87	1.07	1.27		0.0050		0.0052	0.0049
03-JAN-87							
04-JAN-87	2.15	2.31		0.0047		0.0049	0.0045
05-JAN-87	2.42	2.56	4.86	0.0045	0.0138	0.0047	0.0043
06-JAN-87	3.20	3.30		0.0046		0.0047	0.0044
07-JAN-87	4.93	5.08		0.0047		0.0049	0.0045
08-JAN-87	3.27	3.42		0.0046		0.0048	0.0045
09-JAN-87	1.64	1.83		0.0044		0.0047	0.0042
10-JAN-87	0.84	0.96		0.0042		0.0044	0.0041
11-JAN-87	3.32	3.49		0.0046		0.0048	0.0044
12-JAN-87	1.35	1.50	4.66	0.0038	0.0219	0.0041	0.0033
13-JAN-87	0.86	1.02		0.0037		0.0041	0.0031
14-JAN-87							
15-JAN-87				0.0038		0.0040	0.0036
16-JAN-87				0.0038		0.0040	0.0037
17-JAN-87				0.0036		0.0037	0.0034
18-JAN-87				0.0035		0.0036	0.0033
19-JAN-87			4.68	0.0038	0.0209	0.0040	0.0036
20-JAN-87				0.0037		0.0038	0.0036
21-JAN-87				0.0035		0.0037	0.0033
22-JAN-87				0.0051		0.0045	0.0042
23-JAN-87				0.0160		0.0166	0.0152
24-JAN-87				0.0150		0.0157	0.0142
25-JAN-87				0.0133		0.0138	0.0127
26-JAN-87			4.82	0.0138	0.0151	0.0145	0.0132
27-JAN-87				0.0137		0.0142	0.0131
28-JAN-87				0.0127		0.0130	0.0120
29-JAN-87				0.0117		0.0123	0.0112
30-JAN-87				0.0116		0.0120	0.0110
31-JAN-87							

TABLE 11: DAILY MEAN VALUES AND STANDARD DEVIATIONS OF PARAMETERS MEASURED WITH THE AWQM AT THE MERSEY RIVER ABOVE MILL FALLS DURING FEBRUARY 1987

0 DATE	1 PH MEAN	2 CD MEAN US/CM	3 CD @25 US/CM	4 WT C MEAN	5 AT C MEAN	6 pH FIELD	7 pH LAB	8 CD LAB US/CM	9 PH L.S.D.	10 PH H.S.D.	11 CD @25 LSD US/CM
01-FEB-87											
02-FEB-87	4.90	21.28	37.87	0.06	-4.36	4.73	5.1	34.3	4.88	4.92	35.96
03-FEB-87	4.89	21.48	38.24	0.08	-5.33				4.88	4.91	36.40
04-FEB-87	4.90	21.08	37.52	0.05	-0.74				4.89	4.92	35.71
05-FEB-87	4.93	21.51	38.28	0.06	-8.16				4.91	4.95	36.43
06-FEB-87	4.93	21.09	37.54	0.06	-9.72				4.91	4.94	35.71
07-FEB-87	4.90	21.43	38.14	0.07	-7.64				4.88	4.92	36.37
08-FEB-87	4.90	21.14	37.63	0.06	1.08				4.87	4.93	35.74
09-FEB-87	4.92	20.77	36.96	0.11	-0.25	4.62	5.1	34.0	4.91	4.94	34.88
10-FEB-87	4.88	21.06	37.48	0.08	-5.29				4.83	4.92	35.53
11-FEB-87	5.04	20.87	37.14	0.07	-9.31				5.00	5.08	35.34
12-FEB-87	4.97	21.07	37.51	0.09	-10.27				4.95	4.99	35.60
13-FEB-87	5.01	20.73	36.90	0.09	-9.06				5.00	5.03	35.16
14-FEB-87	4.99	21.15	37.64	0.09	-9.97				4.90	5.09	35.76
15-FEB-87	5.00	21.30	37.91	0.10	-9.20				4.97	5.03	36.01
16-FEB-87	4.99	21.20	37.73	0.11	-9.50	4.62	4.9	34.2	4.97	5.01	35.80
17-FEB-87	5.01	21.31	37.93	0.10	-2.74				4.99	5.03	36.06
18-FEB-87	5.01	20.93	37.25	0.12	-1.27				5.00	5.02	35.47
19-FEB-87	5.02	21.27	37.86	0.13	-7.96				5.00	5.04	36.00
20-FEB-87	5.04	21.20	37.73	0.13	-6.71				5.02	5.05	35.94
21-FEB-87	5.05	21.30	37.91	0.10	-5.94				5.03	5.06	36.30
22-FEB-87	5.04	20.75	36.94	0.14	-1.09				5.03	5.06	35.11
23-FEB-87	5.05	21.18	37.70	0.13	-1.79	4.62	4.9	34.9	5.04	5.07	35.42
24-FEB-87	5.05	21.20	37.74	0.13	-2.01				5.04	5.07	35.81
25-FEB-87	5.12	21.35	38.00	0.41	-0.34				5.10	5.14	36.02
26-FEB-87	5.13	20.75	36.93	0.15	1.78				5.10	5.15	34.87
27-FEB-87	5.17	20.99	37.36	0.15	-0.39				5.09	5.24	34.99
28-FEB-87	5.14	21.13	37.61	0.16	-2.18				5.12	5.16	35.74

TABLE 11: DAILY MEAN VALUES AND STANDARD DEVIATIONS OF PARAMETERS MEASURED WITH THE AWQM AT THE MERSEY RIVER ABOVE MILL FALLS DURING FEBRUARY 1987

0 DATE	12 CD @25 MSD US/CM	13 WT C LSD	14 WT C MSD	15 AT C LSD	16 AT C MSD	17 H+ MEAN MEQ/L	18 H+ FLD MEQ/L	19 H+ LAB MEQ/L	20 H+ MSD MEQ/L	21 H+ LSD MEQ/L
01-FEB-87										
02-FEB-87	39.79	-0.04	0.16	-4.40	-4.31	0.013	0.019	0.008	0.013	0.012
03-FEB-87	40.07	-0.02	0.19	-5.40	-5.25	0.013			0.013	0.012
04-FEB-87	39.33	-0.06	0.15	-0.81	-0.67	0.012			0.013	0.012
05-FEB-87	40.13	-0.04	0.17	-8.23	-8.08	0.012			0.012	0.011
06-FEB-87	39.38	-0.04	0.16	-9.80	-9.65	0.012			0.012	0.011
07-FEB-87	39.90	-0.05	0.18	-7.72	-7.56	0.013			0.013	0.012
08-FEB-87	39.52	-0.04	0.16	0.78	1.38	0.013			0.013	0.012
09-FEB-87	39.05	0.01	0.20	-0.34	-0.16	0.012	0.024	0.008	0.012	0.011
10-FEB-87	39.44	-0.05	0.20	-5.37	-5.21	0.013			0.015	0.012
11-FEB-87	38.95	-0.08	0.21	-9.39	-9.23	0.009			0.010	0.008
12-FEB-87	39.42	-0.06	0.23	-10.37	-10.18	0.011			0.011	0.010
13-FEB-87	38.63	-0.02	0.21	-9.15	-8.96	0.010			0.010	0.009
14-FEB-87	39.52	-0.04	0.22	-10.04	-9.90	0.011			0.013	0.008
15-FEB-87	39.81	-0.04	0.24	-9.38	-9.02	0.010			0.011	0.009
16-FEB-87	39.66	-0.05	0.28	-9.56	-9.45	0.010	0.024	0.013	0.011	0.010
17-FEB-87	39.80	-0.04	0.23	-2.82	-2.66	0.010			0.010	0.009
18-FEB-87	39.04	-0.02	0.26	-1.38	-1.16	0.010			0.010	0.010
19-FEB-87	39.72	-0.02	0.27	-8.04	-7.88	0.010			0.010	0.009
20-FEB-87	39.52	0.00	0.26	-6.81	-6.61	0.009			0.010	0.009
21-FEB-87	39.53	-0.06	0.26	-6.04	-5.84	0.009			0.009	0.009
22-FEB-87	38.78	0.00	0.27	-1.20	-0.98	0.009			0.009	0.009
23-FEB-87	39.97	-0.03	0.30	-1.86	-1.72	0.009	0.024	0.013	0.009	0.009
24-FEB-87	39.66	-0.03	0.29	-2.09	-1.93	0.009			0.009	0.009
25-FEB-87	39.99	0.28	0.55	-0.42	-0.26	0.008			0.008	0.007
26-FEB-87	38.99	4.76e-03	0.29	1.71	1.85	0.007			0.008	0.007
27-FEB-87	40.03	0.00	0.31	-0.47	-0.30	0.007			0.008	0.006
28-FEB-87	39.48	-5e-03	0.33	-2.27	-2.10	0.007			0.008	0.007

TABLE 12: DAILY MEAN VALUES AND STANDARD DEVIATIONS OF PARAMETERS MEASURED WITH THE AWQM AT THE MERSEY RIVER ABOVE MILL FALLS DURING MARCH 1987

0 DATE	1 PH MEAN	2 CD MEAN US/CM	3 CD @25 US/CM	4 WT C MEAN	5 AT C MEAN	6 pH FIELD	7 pH LAB	8 PH L.S.D.	9 PH H.S.D.	10 CD @25 LSD US/CM	11 CD @25 HSD US/CM
01-MAR-87	5.14	21.55	38.36	0.14	-0.07			5.12	5.16	36.44	40.34
02-MAR-87	5.13	21.06	37.48	0.15	-3.96	4.82	5	5.11	5.15	35.49	39.48
03-MAR-87	5.17	21.40	38.09	0.18	-6.15			5.15	5.19	36.08	40.11
04-MAR-87	5.19	21.31	37.93	0.16	-12.99			5.17	5.20	36.06	39.80
05-MAR-87	5.19	20.97	37.33	0.15	-9.29			5.17	5.21	35.52	39.14
06-MAR-87	5.18	21.14	37.62	0.17	-2.45			5.17	5.20	35.77	39.48
07-MAR-87	5.19	21.46	38.19	0.18	2.94			5.18	5.21	36.36	40.02
08-MAR-87	5.20	21.30	37.91	0.17	4.30			5.18	5.22	35.98	39.85
09-MAR-87	5.20	21.12	37.59	0.17	-1.44	4.92	5	5.18	5.22	35.66	39.53
10-MAR-87	5.23	21.23	37.79	0.19	-10.10			5.16	5.31	35.80	39.78
11-MAR-87	5.26	20.88	37.17	0.41	-9.32			5.24	5.27	35.20	39.15
12-MAR-87	5.02	21.01	37.41	0.51	-4.12			5.00	5.03	35.65	39.16
13-MAR-87	4.86	21.10	37.56	0.56	-1.74			4.83	4.88	35.67	39.44
14-MAR-87	4.84	21.03	37.42	0.80	0.87			4.82	4.87	35.60	39.25
15-MAR-87	4.90	21.32	37.95	1.41	-1.39			4.87	4.93	35.86	40.08
16-MAR-87	4.89	21.14	37.64	3.01	-1.19	4.72	5	4.87	4.91	35.39	39.53
17-MAR-87	4.89	21.10	37.56	7.05	-1.00			4.86	4.91	35.46	39.66
18-MAR-87	4.90	21.13	37.61	13.87	0.24			4.84	4.96	35.60	39.62
19-MAR-87	4.89	21.09	37.53	18.97	1.03			4.86	4.91	35.48	39.59
20-MAR-87											
21-MAR-87											
22-MAR-87											
23-MAR-87	5.07	20.72	36.88	22.42	3.43	4.78	5	5.00	5.15	34.90	38.87
24-MAR-87	5.04	20.96	37.31	22.44	6.77	4.68	5	4.88	5.19	35.38	39.23
25-MAR-87	4.93	20.96	37.31	22.46	8.83	4.76	5	4.90	4.97	35.25	39.37
26-MAR-87	4.93	20.98	37.35	22.55	6.33	4.74	5	4.92	4.95	35.44	39.25
27-MAR-87	4.93	20.76	36.96	22.81	5.35	4.72		4.92	4.95	35.17	38.76
28-MAR-87	4.96	20.94	37.27	22.82	5.97	4.88	5	4.94	4.97	35.10	39.44
29-MAR-87	4.96	21.11	37.57	22.78	6.11	4.78	5	4.91	5.03	35.71	39.44
30-MAR-87	4.97	20.87	37.15	22.86	6.78	4.68	5	4.95	4.98	34.94	39.35
31-MAR-87	4.97	20.46	36.42	22.87	8.01		5	4.95	4.98	34.10	38.75

TABLE 12: DAILY MEAN VALUES AND STANDARD DEVIATIONS OF PARAMETERS MEASURED WITH THE AWQM AT THE MERSEY RIVER ABOVE MILL FALLS DURING MARCH 1987

0 DATE	12 WT C L.S.D.	13 WT C H.S.D.	14 AT C L.S.D.	15 AT C H.S.D.	16 H+ MEAN MEQ/L	17 H+ FLD MEQ/L	18 H+ LAB MEQ/L	19 H+ HSD MEQ/L	20 H+ LSD MEQ/L
01-MAR-87	-0.03	0.31	-0.16	0.013	0.007			0.008	0.007
02-MAR-87	-0.03	0.32	-4.04	-3.875	0.007	0.015	0.01	0.008	0.007
03-MAR-87	9.52e-03	0.34	-6.29	-6.010	0.007			0.007	0.007
04-MAR-87	9.52e-03	0.31	-13.07	-12.914	0.007			0.007	0.006
05-MAR-87	-0.03	0.34	-9.38	-9.200	0.007			0.007	0.006
06-MAR-87	0.00	0.33	-2.53	-2.367	0.007			0.007	0.006
07-MAR-87	1.93e-19	0.36	2.90	2.989	0.006			0.007	0.006
08-MAR-87	0.02	0.32	4.22	4.386	0.006			0.007	0.006
09-MAR-87	-6.67e-03	0.35	-1.50	-1.380	0.006	0.012	0.01	0.007	0.006
10-MAR-87	9.52e-03	0.37	-10.20	-9.995	0.006			0.007	0.005
11-MAR-87	0.21	0.61	-9.31	-9.106	0.006			0.006	0.005
12-MAR-87	0.33	0.69			0.011			0.010	0.009
13-MAR-87	0.39	0.73			0.014			0.015	0.013
14-MAR-87	0.68	0.93			0.014			0.015	0.014
15-MAR-87	1.27	1.55			0.013			0.013	0.012
16-MAR-87	2.88	3.13			0.013	0.019	0.01	0.013	0.012
17-MAR-87	6.87	7.22			0.013			0.014	0.012
18-MAR-87	13.68	14.06			0.013			0.014	0.011
19-MAR-87	18.80	19.13			0.013			0.014	0.012
20-MAR-87									
21-MAR-87									
22-MAR-87									
23-MAR-87	22.24	22.59			0.009	0.017	0.01	0.010	0.007
24-MAR-87	22.28	22.61			0.010	0.021	0.01	0.013	0.006
25-MAR-87	22.29	22.64			0.012	0.017	0.01	0.013	0.011
26-MAR-87	22.39	22.70			0.012	0.018	0.01	0.012	0.011
27-MAR-87	22.62	22.99			0.012	0.019		0.012	0.011
28-MAR-87	22.65	22.99			0.011	0.013	0.01	0.012	0.011
29-MAR-87	22.60	22.97			0.011	0.017	0.01	0.012	0.009
30-MAR-87	22.67	23.04			0.011	0.021	0.01	0.011	0.010
31-MAR-87	22.70	23.03			0.011		0.01	0.011	0.010

TABLE 13: DAILY MEAN VALUES AND STANDARD DEVIATIONS OF PARAMETERS MEASURED WITH THE AWQM AT THE MERSEY RIVER ABOVE MILL FALLS DURING APRIL 1987

0 DATE	1 PH MEAN	2 PH LAB	3 pH FIELD	4 CD MEAN US/CM	5 CD @25 US/CM	6 WT C MEAN	7 WT C CAL	8 AT C MEAN	9 PH L.S.D.	10 PH H.S.D.	11 CD @25 LSD US/CM
01-APR-87	4.93	5.0	4.78	19.35	32.85	23.29	2.81	8.49	4.92	4.95	30.25
02-APR-87	4.94	5.0	4.80	18.90	32.87	23.32	0.32	4.47	4.92	4.96	30.87
03-APR-87	4.92	4.9	4.58	18.59	32.08	23.51	3.59	8.74	4.91	4.93	30.58
04-APR-87	4.88	4.9	4.58	18.36	32.37	23.70		2.33	4.87	4.90	
05-APR-87	4.79	4.8	4.54	17.73	31.91	24.16		6.92	4.78	4.80	
06-APR-87	4.79	4.8	4.69	17.53	32.14	24.69	-1.67	5.55	4.77	4.81	30.44
07-APR-87	4.77	4.8	4.47	19.22	32.06	24.89	3.81	6.91	4.74	4.79	29.86
08-APR-87	4.78	4.8	4.39	18.64	31.66	25.18	3.70	4.02	4.76	4.79	28.76
09-APR-87	4.77		4.52	18.67	31.11	25.24	4.82	2.81	4.76	4.79	28.71
10-APR-87	4.78		4.58	17.70	30.90	25.47	1.58	9.45	4.76	4.80	29.00
11-APR-87	4.82		4.62	17.37	31.52	25.50		-0.72	4.79	4.84	
12-APR-87	4.87		4.56	20.62	30.90	27.21		9.45	4.79	4.95	
13-APR-87	4.84		4.68	21.52	31.00	28.48	5.94	3.77	4.83	4.85	28.50
14-APR-87	4.86		4.74	21.16		28.25		4.12	4.84	4.88	
15-APR-87	4.85		4.74	22.90		28.53		8.09	4.83	4.88	
16-APR-87	4.89		4.88	25.59		28.86		7.67	4.88	4.91	
17-APR-87	4.91		4.96	26.05		29.04		4.57	4.88	4.95	
18-APR-87	4.93		4.66	26.17		29.00		9.28	4.92	4.95	
19-APR-87	4.94		4.62	25.90		29.30		15.38	4.93	4.96	
20-APR-87	4.98		4.84	27.72		29.86		17.94	4.97	5.00	
21-APR-87	4.99		4.87	28.73		30.34		104.09	4.98	5.01	
22-APR-87	5.02			29.09		30.70		13.77	5.01	5.04	
23-APR-87	5.05			28.13		30.28		6.31	5.04	5.06	
24-APR-87	5.05			28.28		30.38		10.40	5.03	5.06	
25-APR-87	5.05			28.05		30.25		9.48	5.03	5.07	
26-APR-87	5.09			28.40		30.40		11.41	5.07	5.10	
27-APR-87	5.08			28.27		30.43		7.10	5.05	5.11	
28-APR-87	5.10			28.28		30.35		5.74	5.08	5.12	
29-APR-87	5.09			27.08		29.93		4.28	5.08	5.11	

TABLE 13: DAILY MEAN VALUES AND STANDARD DEVIATIONS OF PARAMETERS MEASURED WITH THE AWQM AT THE MERSEY RIVER ABOVE MILL FALLS DURING APRIL 1987

0 DATE	12 CD @25 HSD US/CM	13 WT C L.S.D.	14 WT C H.S.D.	15 AT C L.S.D.	16 AT C H.S.D.	17 H+ MEAN MEQ/L	18 H+ FLD MEQ/L	19 H+ LAB MEQ/L	20 H+ HSD MEQ/L	21 H+ LSD MEQ/L
01-APR-87	35.45	23.10	23.47	8.42	8.55	0.012	0.017	0.010	0.012	0.011
02-APR-87	34.87	23.13	23.53	4.41	4.53	0.012	0.016	0.010	0.012	0.011
03-APR-87	33.58	23.35	23.67	8.65	8.83	0.012	0.026	0.013	0.012	0.012
04-APR-87		23.59	23.81	2.28	2.39	0.013	0.026	0.013	0.014	0.013
05-APR-87		23.95	24.37	6.84	7.01	0.016	0.029	0.016	0.017	0.016
06-APR-87	33.84	24.51	24.87	5.50	5.60	0.016	0.020	0.016	0.017	0.016
07-APR-87	34.26	24.70	25.07	6.82	7.01	0.017	0.034	0.016	0.018	0.016
08-APR-87	34.56	25.01	25.35	3.96	4.07	0.017	0.041	0.016	0.017	0.016
09-APR-87	33.51	25.08	25.40	2.74	2.88	0.017	0.030		0.017	0.016
10-APR-87	32.80	25.32	25.62	9.38	9.52	0.017	0.026		0.017	0.016
11-APR-87		25.40	25.60	-0.80	-0.63	0.015	0.024		0.016	0.014
12-APR-87		27.03	27.38	9.37	9.53	0.014	0.028		0.016	0.011
13-APR-87	33.50	28.33	28.63	3.72	3.83	0.015	0.021		0.015	0.014
14-APR-87		28.06	28.44	4.03	4.20	0.014	0.018		0.014	0.013
15-APR-87		28.37	28.68	8.02	8.17	0.014	0.018		0.015	0.013
16-APR-87		28.71	29.00	7.60	7.74	0.013	0.013		0.013	0.012
17-APR-87		28.89	29.18	4.50	4.65	0.012	0.011		0.013	0.011
18-APR-87		28.87	29.12	9.21	9.35	0.012	0.022		0.012	0.011
19-APR-87		29.12	29.48	15.32	15.45	0.011	0.024		0.012	0.011
20-APR-87		29.68	30.03	17.86	18.03	0.010	0.014		0.011	0.010
21-APR-87		30.16	30.51	104.04	104.14	0.010	0.013		0.010	0.010
22-APR-87		30.55	30.86	13.73	13.82	0.010			0.010	0.009
23-APR-87		30.09	30.47	6.23	6.39	0.009			0.009	0.009
24-APR-87		30.20	30.55	10.33	10.48	0.009			0.009	0.009
25-APR-87		30.08	30.42	9.42	9.54	0.009			0.009	0.008
26-APR-87		30.24	30.56	11.31	11.50	0.008			0.008	0.008
27-APR-87		30.26	30.60	7.02	7.17	0.008			0.009	0.008
28-APR-87		30.18	30.51	5.66	5.81	0.008			0.008	0.008
29-APR-87		29.73	30.13	4.20	4.36	0.008			0.008	0.008

TABLE 14: MONTHLY STATISTICS FOR THE AWQM HOURLY PH DATA IN THE MERSEY RIVER ABOVE MILL FALLS BETWEEN OCTOBER 1986 AND APRIL 1987

0 DATE	1 PH MEAN	2 PH MEDIAN	3 PH MAX.	4 PH MIN.
OCT 86	5.12	5.11	5.50	4.88
NOV 86	5.28	5.27	5.42	4.76
DEC 86	5.23	5.23	5.54	5.00
JAN 87	5.26	5.36	5.98	4.62
FEB 87	5.00	5.00	5.60	3.67
MAR 87	5.04	5.00	5.55	4.65
APR 87	4.93	4.93	5.52	4.61

TABLE 15: MONTHLY STATISTICS FOR THE AWQM HOURLY CONDUCTIVITY DATA IN THE MERSEY RIVER ABOVE MILL FALLS BETWEEN OCTOBER 1986 AND APRIL 1987

0 DATE	1 CD MEAN US/CM	2 CD MED. US/CM	3 CD MAX. US/CM	4 CD MIN. US/CM
OCT 86	31.52	31.39	35.38	27.98
NOV 86	25.25	24.07	35.38	17.98
DEC 86	30.10	30.42	42.71	22.27
JAN 87	31.37	32.33	51.62	27.95
FEB 87	37.63	37.56	42.90	34.18
MAR 87				
APR 87				

TABLE 16: METEOROLOGICAL CHARACTERISTICS AND MERSEY RIVER DISCHARGE AT THE KEJIMKUJIK NATIONAL PARK AREA DURING OCTOBER 1986 TO APRIL 1987

0 DATE	1 MAX. TEMP. C	2 MIN. TEMP. C	3 SNOW DEPTH CM	4 WATER CONT CM	5 SNOW PACK CM	6 H+ MEQ/L	7 PH	8 PREC. DEPTH MM	9 DISCH M**3/S
1 01-OCT-86	18.0	14.5				0.138038	3.86	0.8	4.71
2 02-OCT-86	19.0	6.0						0.2	4.66
3 03-OCT-86	16.5	5.5							4.71
4 04-OCT-86	18.5	9.0				0.034674	4.46	2.2	4.69
5 05-OCT-86	12.5	6.5				0.016596	4.78	11.2	5.15
6 06-OCT-86	8.0	0.5							5.30
7 07-OCT-86	10.0	3.0				0.021878	4.66	5.8	5.34
8 08-OCT-86	9.0	-1.0							5.18
9 09-OCT-86	14.0	7.0							5.04
10 10-OCT-86	18.0	1.5				0.173780	3.76	1.4	4.96
11 11-OCT-86	8.0	-2.0							4.76
12 12-OCT-86	10.0	0.5							4.74
13 13-OCT-86	15.0	1.0							4.55
14 14-OCT-86	14.5	5.0						0.4	4.62
15 15-OCT-86	18.0	12.0				0.007244	5.14	19.6	5.57
16 16-OCT-86	14.5	2.0							5.39
17 17-OCT-86	12.0	3.0				0.017378	4.76	6.0	5.12
18 18-OCT-86	8.5	3.0						0.2	5.05
19 19-OCT-86	6.0	-2.0							5.11
20 20-OCT-86	12.0	0.0							5.13
21 21-OCT-86	11.0	-1.5							4.96
22 22-OCT-86	11.5	3.5				0.095499	4.02	3.2	5.03
23 23-OCT-86	11.0	4.5							5.20
24 24-OCT-86	16.5	2.5				0.069183	4.16	1.0	5.23
25 25-OCT-86	5.5	-2.5						0.2	5.10
26 26-OCT-86	10.0	1.0							4.79
27 27-OCT-86	12.5	4.0				0.006607	5.18	4.0	4.55
28 28-OCT-86	10.0	7.0				0.010471	4.98	6.2	4.71
29 29-OCT-86	11.4	4.0							4.62
30 30-OCT-86	14.0	8.0							4.39
31 31-OCT-86	15.5	-1.0							4.16
32 01-NOV-86	15.5	-3.0							4.06
33 02-NOV-86	13.0	6.0							3.95
34 03-NOV-86	13.0	-3.5				0.104713	3.98	5.8	4.09
35 04-NOV-86	5.5	-2.5							3.94
36 05-NOV-86	5.5	-5.0						0.6	3.75
37 06-NOV-86	5.5	-5.0							3.79
38 07-NOV-86	4.5	1.0				0.004169	5.38	15.6	4.37
39 08-NOV-86	9.5	-0.5							4.32
40 09-NOV-86	13.0	-0.5				0.016596	4.78	2.0	4.27
41 10-NOV-86	17.0	-0.5				0.034674	4.46	12.4	4.90
42 11-NOV-86	4.0	-3.5							4.96
43 12-NOV-86	3.5	-0.5				0.012023	4.92	8.8	4.97
44 13-NOV-86	3.5	-0.5						0.2	5.02
45 14-NOV-86	6.5	-10.0				0.218776	3.66	1.2	5.25
46 15-NOV-86	4.5	-8.5							5.18
47 16-NOV-86	6.5	0.0						0.2	5.24
48 17-NOV-86	8.0	-2.0							5.17
49 18-NOV-86	6.0	0.0							5.14
50 19-NOV-86	9.0	-4.0							5.20
51 20-NOV-86	-2.5	-10.5	20		2	0.015136	4.82	21.0	5.23

TABLE 16: METEOROLOGICAL CHARACTERISTICS AND MERSEY RIVER DISCHARGE AT THE KEJIMKUJIK NATIONAL PARK AREA DURING OCTOBER 1986 TO APRIL 1987

0 DATE	1 MAX. TEMP. C	2 MIN. TEMP. C	3 SNOW DEPTH CM	4 WATER CONT CM	5 SNOW PACK CM	6 H+ MEQ/L	7 PH	8 PREC. DEPTH MM	9 DISCH M**3/S
52 21-NOV-86	2.5	-2.0						0.2	5.40
53 22-NOV-86	8.5	-3.5				0.018197	4.74	23.6	7.73
54 23-NOV-86	-2.5	-5.0						0.6	7.65
55 24-NOV-86	6.5	6.0						0.6	8.00
56 25-NOV-86	11.5	1.5				0.010471	4.98	17.2	10.60
57 26-NOV-86	11.5	-5.0							10.90
58 27-NOV-86	13.0	1.0				0.014454	4.84	24.2	14.40
59 28-NOV-86	13.5	-4.0							17.60
60 29-NOV-86	5.5	-1.0							17.90
61 30-NOV-86	6.5	-2.5						0.6	18.30
62 01-DEC-86	-1.5	-7.5							17.90
63 02-DEC-86	-0.5	-9.0							16.50
64 03-DEC-86	5.0	-3.0				0.009120	5.04	2.8	16.60
65 04-DEC-86	13.0	2.0				0.004365	5.36	39.8	22.10
66 05-DEC-86	7.0	1.0				0.275423	3.56	1.3	21.20
67 06-DEC-86	4.0	-4.0							20.60
68 07-DEC-86	3.0	-3.0				0.181970	3.74	1.4	20.30
69 08-DEC-86	2.5	-5.5			3.0	0.064565	4.19	4.5	18.30
70 09-DEC-86	-5.0	-16.0			3.0				17.90
71 10-DEC-86	5.5	-11.0			7.0	0.010471	4.98	19.2	16.70
72 11-DEC-86	5.0	-3.0			4.0				15.20
73 12-DEC-86	0.0	-3.0			8.0	0.017378	4.76	5.4	13.80
74 13-DEC-86	3.0	-6.5			6.0	0.022909	4.64	0.6	12.60
75 14-DEC-86	-6.0	-12.0			6.0			0.2	11.70
76 15-DEC-86	3.0	-4.0			6.0				10.60
77 16-DEC-86	2.5	-8.5			5.0				9.45
78 17-DEC-86	-3.5	-14.0			4.5				8.62
79 18-DEC-86	-3.5	-11.0			5.0				7.78
80 19-DEC-86	1.5	-7.0			5.0				7.28
81 20-DEC-86	2.0	0.5			5.0	0.008710	5.06	14.4	7.95
82 21-DEC-86	1.0	-5.5			5.0			0.4	7.22
83 22-DEC-86	-2.5	-12.0			5.0				6.67
84 23-DEC-86	1.0	-8.0			5.0				6.35
85 24-DEC-86	4.0	-2.5			5.0				6.04
86 25-DEC-86	1.5	-7.5			4.0				5.82
87 26-DEC-86	10.0	1.0			0.0	0.010471	4.98	26.8	8.61
88 27-DEC-86	4.5	-4.5							9.20
89 28-DEC-86	-1.5	-10.0							8.62
90 29-DEC-86	1.0	-7.0							8.26
91 30-DEC-86	3.5	-3.5							8.05
92 31-DEC-86	1.0	-3.5			10.0	0.009333	5.03	5.6	7.83
93 01-JAN-87	-3.0	-10.5			9.0			0.2	9.53
94 02-JAN-87	0.0	-8.5			2.0				9.04
95 03-JAN-87	3.5	-2.5			7.0	0.017783	4.75	28.4	9.35
96 04-JAN-87	3.0	-4.5			9.0	0.100000	4.00	9.8	10.00
97 05-JAN-87	-3.0	-5.0			9.0				9.48
98 06-JAN-87	-1.0	-10.0			9.0				9.27
99 07-JAN-87	0.5	-7.5			9.0				8.26
100 08-JAN-87	-1.5	-2.5			6.0	0.158489	3.80	1.8	8.04
101 09-JAN-87	-2.0	-7.0			7.0			0.8	7.97
102 10-JAN-87	-2.5	-12.5			7.0				8.16

TABLE 16: METEOROLOGICAL CHARACTERISTICS AND MERSEY RIVER DISCHARGE AT THE KEJIMKUJIK NATIONAL PARK AREA DURING OCTOBER 1986 TO APRIL 1987

0 DATE	1 MAX. TEMP. C	2 MIN. TEMP. C	3 SNOW DEPTH CM	4 WATER CONT CM	5 SNOW PACK CM	6 H+ MEQ/L	7 PH	8 PREC. DEPTH MM	9 DISCH M**3/S
103 11-JAN-87	0.5	-10.0			15.0	0.020893	4.68	13.0	7.35
104 12-JAN-87	1.5	-4.0			16.0	0.016596	4.78	12.8	7.18
105 13-JAN-87	-3.5	-6.0	20	4	24.0	0.000380	6.42	8.0	8.05
106 14-JAN-87	-2.5	-6.5			21.0			0.2	9.05
107 15-JAN-87	-2.0	-5.5			20.0				8.75
108 16-JAN-87	4.0	-3.0			18.0			0.6	6.10
109 17-JAN-87	-1.0	-13.0			19.0			0.2	
110 18-JAN-87	-9.0	-17.0			19.0			0.2	
111 19-JAN-87	1.0	-12.0			26.0	0.020893	4.68	19.4	
112 20-JAN-87	-0.5	-10.5	18	4	26.0			0.2	
113 21-JAN-87	-7.0	-17.0			26.0			0.2	
114 22-JAN-87	-5.0	-13.5			27.0	0.087096	4.06	2.8	19.20
115 23-JAN-87	7.0	-12.0			29.0	0.005248	5.28	26.6	20.20
116 24-JAN-87	4.0	-9.5			28.0	0.120226	3.92	2.2	17.40
117 25-JAN-87	-4.0	-13.0			32.0	0.066069	4.18	4.0	
118 26-JAN-87	-9.0	-15.5			30.0			0.2	
119 27-JAN-87	-11.5	-15.5	24	5	41.0	0.003802	5.42	16.1	
120 28-JAN-87	-7.0	-17.0			40.0				
121 29-JAN-87	-5.0	-17.0			39.0				
122 30-JAN-87	-3.0	-14.5			39.0				
123 31-JAN-87	-2.5	-13.0			50.0	0.005495	5.26	13.2	
124 01-FEB-87	-2.0	-6.0			60.0	0.013183	4.88	25.6	
125 02-FEB-87	-4.0	-9.0			65.0	0.008710	5.06	4.0	
126 03-FEB-87	-2.0	-10.5	46	12	62.0				
127 04-FEB-87	0.5	-8.0			60.0	0.208930	3.68	2.0	
128 05-FEB-87	-1.0	-12.0			62.0	0.120226	3.92	2.0	
129 06-FEB-87	-8.0	-15.5			60.0			0.8	
130 07-FEB-87	-5.5	-15.5			60.0				
131 08-FEB-87	-1.5	-13.0			57.0			0.2	
132 09-FEB-87	3.0	-3.5			56.0				
133 10-FEB-87	-1.0	-8.0			70.0	0.017378	4.76	18.6	
134 11-FEB-87	-7.0	-10.0	66	18	74.0	0.016218	4.79	5.2	
135 12-FEB-87	-7.5	-16.5			67.0	0.035481	4.45	2.0	
136 13-FEB-87	-9.0	-13.0			66.0				
137 14-FEB-87	-9.0	-16.0			66.0	0.083176	4.08	1.2	
138 15-FEB-87	-11.0	-18.0			64.0			0.4	
139 16-FEB-87	-9.0	-16.5			65.0	0.007079	5.15	0.8	
140 17-FEB-87	-3.0	-12.0	62	20	62.0				
141 18-FEB-87	0.5	-13.0			61.0				
142 19-FEB-87	-0.5	-14.0			61.0				
143 20-FEB-87	-3.0	-10.5			60.0			0.2	
144 21-FEB-87	-4.0	-12.5			59.0				
145 22-FEB-87	-1.0	-8.0			59.0			0.2	
146 23-FEB-87	1.0	-8.5			58.0				
147 24-FEB-87	-0.5	-7.0	54	14	58.0				
148 25-FEB-87	-0.5	-4.0			57.0				
149 26-FEB-87	1.5	-2.0			56.0				
150 27-FEB-87	0.0	-9.5			56.0				
151 28-FEB-87	3.0	-9.0			55.0				
152 01-MAR-87	6.0	-7.5			51.0				
153 02-MAR-87	3.0	-7.0			65.0	0.002754	5.56	27.8	

TABLE 16: METEOROLOGICAL CHARACTERISTICS AND MERSEY RIVER DISCHARGE AT THE KEJIMKUJIK NATIONAL PARK AREA DURING OCTOBER 1986 TO APRIL 1987

0 DATE	1 MAX. TEMP. C	2 MIN. TEMP. C	3 SNOW DEPTH CM	4 WATER CONT CM	5 SNOW PACK CM	6 H+ MEQ/L	7 PH	8 PREC. DEPTH MM	9 DISCH M**3/S
154 03-MAR-87	-3.0	-9.0			75.0	0.014454	4.84	10.8	
155 04-MAR-87	-5.0	-18.0	66	18	74.0				
156 05-MAR-87	-3.0	-15.5			71.0				
157 06-MAR-87	0.0	-12.5			70.0				
158 07-MAR-87	5.0	-3.5			66.0			0.2	5.50
159 08-MAR-87	5.0	-2.0			63.0			0.2	5.39
160 09-MAR-87	7.0	-4.0			60.0				5.56
161 10-MAR-87	0.5	-16.5	52	18	62.0	0.120226	3.92	3.2	5.25
162 11-MAR-87	-7.0	-16.0			62.0				4.51
163 12-MAR-87	1.0	-15.0			61.0				4.26
164 13-MAR-87	3.5	-8.5			61.0				4.17
165 14-MAR-87	5.5	-5.0			60.0				4.10
166 15-MAR-87	-2.0	-6.5			60.0				3.80
167 16-MAR-87	-1.5	-4.0			65.0	0.005495	5.26	6.8	3.81
168 17-MAR-87	-2.0	-4.0	64	20	73.0	0.005754	5.24	6.0	4.09
169 18-MAR-87	0.0	-3.0			72.0			0.8	4.01
170 19-MAR-87	2.0	-1.5			73.0	0.013183	4.88	8.0	4.61
171 20-MAR-87	2.0	-1.0			72.0			3.2	4.73
172 21-MAR-87	2.0	-1.0			87.0	0.020893	4.68	35.2	9.02
173 22-MAR-87	3.0	0.0			82.0	0.013183	4.88	24.2	15.80
174 23-MAR-87	5.5	-1.5			77.0				12.90
175 24-MAR-87	8.0	-1.5	50	22	69.0				9.77
176 25-MAR-87	12.5	0.5			62.0				9.30
177 26-MAR-87	18.5	-1.5			59.0				8.50
178 27-MAR-87	8.5	1.0			54.0	0.018197	4.74	1.2	8.80
179 28-MAR-87	11.0	-0.5			47.0				9.96
180 29-MAR-87	11.0	1.0			46.0				11.20
181 30-MAR-87	13.5	0.5			38.0				13.10
182 31-MAR-87	15.0	-1.0	30	10	33.0				15.30
183 01-APR-87	9.0	4.0			18.0				20.20
184 02-APR-87	9.0	2.0			14.0	0.019953	4.70	9.6	29.40
185 03-APR-87	9.0	-2.0			9.0				38.20
186 04-APR-87	16.0	3.0			8.0				47.80
187 05-APR-87	17.5	2.5			2.0			0.2	56.20
188 06-APR-87	7.0	4.0			0.0	0.028184	4.55	5.4	60.90
189 07-APR-87	6.0	2.5			0.0	0.013804	4.86	7.8	63.60
190 08-APR-87	9.8	1.0			0.0	0.131826	3.88	5.0	63.00
191 09-APR-87	5.0	-1.0			0.0	0.006918	5.16	1.0	59.10
192 10-APR-87	4.0	-1.5			0.0			0.2	52.50
193 11-APR-87	14.0	-0.5			0.0				44.90
194 12-APR-87	16.0	2.5			0.0				38.20
195 13-APR-87	18.0	-0.5			0.0	0.301995	3.52	3.6	32.90
196 14-APR-87	7.0	-2.0			0.0				27.50
197 15-APR-87	10.0	0.0			0.0				24.60
198 16-APR-87	16.5	0.0			0.0				21.70
199 17-APR-87	14.0	0.5			0.0				19.20
200 18-APR-87	8.5	2.5			0.0			0.6	17.90
201 19-APR-87	16.0	7.5			0.0	0.033113	4.48	2.4	16.70
202 20-APR-87	22.0	12.5			0.0	0.007244	5.14	3.0	15.80
203 21-APR-87	21.5	6.0			0.0				14.60
204 22-APR-87	22.0	5.5			0.0	0.019055	4.72	2.4	13.50

TABLE 16: METEOROLOGICAL CHARACTERISTICS AND MERSEY RIVER DISCHARGE AT THE KEJIMKUJIK NATIONAL PARK AREA DURING OCTOBER 1986 TO APRIL 1987

0 DATE	1 MAX. TEMP. C	2 MIN. TEMP. C	3 SNOW DEPTH CM	4 WATER CONT CM	5 SNOW PACK CM	6 H+ MEQ/L	7 PH	8 PREC. DEPTH MM	9 DISCH M**3/S
205 23-APR-87	9.0	-1.5			0.0	0.012023	4.92	5.4	12.50
206 24-APR-87	13.5	4.5			0.0			0.2	11.60
207 25-APR-87	13.5	1.0			0.0			0.2	10.80
208 26-APR-87	11.5	-1.0			0.0				9.76
209 27-APR-87	14.0	-2.5			0.0				8.53
210 28-APR-87	11.5	-3.5			0.0				7.72
211 29-APR-87	7.0	0.5			0.0	0.004169	5.38	24.6	8.24
212 30-APR-87	8.0	2.0			0.0	0.087096	4.06	6.6	9.04

TABLE 17: SNOW CHEMISTRY AT THE CAPMON SITE IN THE MERSEY RIVER BASIN IN THE KEJIMKUJIK NATIONAL PARK DURING WINTER 1986-87

0	1 DATE	2 PH LAB	3 H+ LAB MEQ/L	4 NOX MEQ/L	5 SO4 IC MEQ/L	6 DOC MG/L
	20-NOV-86	5.2	0.006310	0.002844	0.01040	0.5
	13-JAN-87	5.0	0.010000	0.004977	0.01040	0.5
	20-JAN-87	4.7	0.019953	0.011376	0.02288	0.5
	27-JAN-87	4.9	0.012589	0.010665	0.01248	0.5
	03-FEB-87	5.2	0.006310	0.004266	0.01456	0.5
	11-FEB-87	4.9	0.012589	0.009243	0.01664	0.5
	17-FEB-87	4.8	0.015849	0.009954	0.02288	0.5
	24-FEB-87	4.7	0.019953	0.014220	0.02288	0.5
	03-MAR-87	4.8	0.015849	0.009243	0.02080	1.9
	10-MAR-87	4.9	0.012589	0.012087	0.02496	0.5
	17-MAR-87	5.2	0.006310	0.002133	0.02080	1.1
	24-MAR-87	5.3	0.005012		0.01664	
	31-MAR-87	5.3	0.005012		0.01040	

TABLE 18: PH, HYDROGEN, NITRATE-NITRITE, AND SULPHATE IONS AND DOC CONCENTRATIONS IN THE MERSEY RIVER ABOVE MILL FALLS BETWEEN OCTOBER 1986 AND APRIL 1987

0	1 DATE	2 PH LAB	3 H+ LAB MEQ/L	4 PH FIELD	5 H+ FLD MEQ/L	6 NOX MEQ/L	7 SO4 IC MEQ/L	8 DOC MG/L
1	20-OCT-86	5.0	0.010000	5.12	0.007586	0.001422	0.03536	13.0
2	24-OCT-86	5.1	0.007943			0.000711	0.03744	16.0
3	27-OCT-86	5.0	0.010000	5.16	0.006918	0.001422	0.03536	14.0
4	03-NOV-86	5.1	0.007943	5.16	0.006918	0.002133	0.03536	14.0
5	03-NOV-86	5.0	0.010000	5.16	0.006918	0.001422	0.03536	14.0
6	03-NOV-86	5.0	0.010000	5.16	0.006918	0.000711	0.03536	14.0
7	05-NOV-86	5.2	0.006310			0.000711	0.03744	15.0
8	10-NOV-86	5.1	0.007943	4.86	0.013804	0.000711	0.04368	12.0
9	17-NOV-86	5.1	0.007943	5.06	0.008710	0.000711	0.03744	14.0
10	24-NOV-86	5.0	0.010000	5.06	0.008710	0.000711	0.04160	14.0
11	25-NOV-86	5.0	0.010000			0.001422	0.03952	15.0
12	29-NOV-86	4.9	0.012589			0.000711	0.04576	7.8
13	01-DEC-86	5.0	0.010000	4.74	0.018197	0.000711	0.04160	15.0
14	01-DEC-86	4.9	0.012589	4.74	0.018197	0.000711	0.03744	15.0
15	01-DEC-86	4.9	0.012589	4.74	0.018197	0.000711	0.03744	14.0
16	08-DEC-86	4.8	0.015849	4.70	0.019953	0.000711	0.04160	14.0
17	15-DEC-86	4.9	0.012589	4.85	0.014125	0.000711	0.04368	13.0
18	20-DEC-86	5.0	0.010000				0.04368	10.0
19	22-DEC-86	4.9	0.012589	4.78	0.016596	0.000711	0.04160	13.0
20	29-DEC-86	5.0	0.010000	4.82	0.015136	0.000711	0.04784	11.0
21	29-DEC-86	4.9	0.012589	4.82	0.015136	0.000711	0.04576	11.0
22	29-DEC-86	4.8	0.015849	4.82	0.015136	0.000711	0.04784	11.0
23	05-JAN-87	4.8	0.015849	4.86	0.013804	0.000711	0.04784	11.0
24	12-JAN-87	4.9	0.012589	4.66	0.021878	0.000711	0.04784	11.0
25	14-JAN-87	5.0	0.010000				0.04784	8.9
26	19-JAN-87	4.9	0.012589	4.68	0.020893	0.000711	0.05200	12.0
27	22-JAN-87	5.5	0.003162				0.05408	8.2
28	26-JAN-87	4.9	0.012589	4.82	0.015136	0.000711	0.04992	9.9
29	26-JAN-87	5.0	0.010000	4.82	0.015136	0.000711	0.04992	10.0
30	26-JAN-87	5.0	0.010000	4.82	0.015136	0.000711	0.04784	10.0
31	02-FEB-87	4.9	0.012589	4.73	0.018621	0.000711	0.05200	12.0
32	09-FEB-87	4.9	0.012589	4.62	0.023988	0.000711	0.04992	12.0
33	12-FEB-87	5.0	0.010000				0.04368	7.4
34	16-FEB-87	4.9	0.012589	4.62	0.023988	0.000711	0.05200	11.0
35	23-FEB-87	4.9	0.012589	4.62	0.023988	0.000711	0.05200	10.0
36	23-FEB-87	4.9	0.012589	4.62	0.023988	0.000711	0.05200	10.0
37	23-FEB-87	4.9	0.012589	4.62	0.023988	0.000711	0.05408	10.0
38	02-MAR-87	5.0	0.010000	4.82	0.015136	0.000711	0.05408	10.0
39	09-MAR-87	5.0	0.010000	4.92	0.012023	0.002133	0.05200	10.0
40	09-MAR-87	5.0	0.010000	4.92	0.012023	0.002133	0.05200	10.0
41	09-MAR-87	5.0	0.010000	4.92	0.012023	0.000711	0.05408	10.0
42	16-MAR-87	5.0	0.010000	4.72	0.019055	0.000711	0.04784	10.0
43	23-MAR-87	5.0	0.010000	4.78	0.016596	0.000711	0.05408	7.7
44	24-MAR-87	5.0	0.010000	4.68	0.020893	0.000711	0.05616	8.0
45	25-MAR-87	5.0	0.010000	4.76	0.017378	0.000711	0.06032	7.9
46	26-MAR-87	5.0	0.010000	4.74	0.018197	0.000711	0.06032	7.5
47	27-MAR-87			4.72	0.019055	0.000711	0.05616	7.5
48	28-MAR-87	5.0	0.010000	4.88	0.013183	0.000711	0.06032	7.0
49	29-MAR-87	5.0	0.010000	4.78	0.016596	0.000711	0.05616	7.3
50	30-MAR-87	5.0	0.010000	4.68	0.020893	0.000711	0.05200	7.3

TABLE 18: PH, HYDROGEN, NITRATE-NITRITE, AND SULPHATE IONS AND DOC CONCENTRATIONS IN THE MERSEY RIVER ABOVE MILL FALLS BETWEEN OCTOBER 1986 AND APRIL 1987

0	1 DATE	2 PH LAB	3 H+ LAB MEQ/L	4 PH FIELD	5 H+ FLD MEQ/L	6 NOX MEQ/L	7 SO4 IC MEQ/L	8 DOC MG/L
51	31-MAR-87	5.0	0.010000	4.98	0.010471	0.000711	0.04992	6.2
52	01-APR-87	5.0	0.010000	4.78	0.016596	0.000711	0.04992	5.9
53	02-APR-87	5.0	0.010000	4.80	0.015849	0.000711	0.04992	7.2
54	03-APR-87	4.9	0.012589	4.58	0.026303	0.000711	0.04992	7.3
55	04-APR-87	4.9	0.012589	4.58	0.026303	0.000711	0.04992	7.2
56	05-APR-87	4.8	0.015849	4.54	0.028840	0.000711	0.05200	7.2
57	06-APR-87	4.8	0.015849	4.69	0.020417	0.000711	0.04992	7.5
58	06-APR-87	4.8	0.015849	4.69	0.020417	0.001422	0.04576	6.9
59	06-APR-87	4.8	0.015849	4.69	0.020417	0.000711	0.04576	7.2
60	07-APR-87	4.8	0.015849	4.47	0.033884	0.000711	0.04576	7.0
61	08-APR-87	4.8	0.015849	4.39	0.040738	0.000711	0.04576	7.0
62	09-APR-87	4.9	0.012589	4.52	0.030200	0.000711	0.03952	7.4
63	10-APR-87	4.9	0.012589	4.58	0.026303	0.000711	0.03952	7.1
64	11-APR-87	5.0	0.010000	4.62	0.023988	0.000711	0.03952	7.3
65	12-APR-87	5.0	0.010000	4.56	0.027542	0.000711	0.04368	6.5
66	13-APR-87	5.0	0.010000	4.68	0.020893	0.000711	0.04368	7.0
67	14-APR-87	4.9	0.012589	4.74	0.018197	0.000711	0.04368	7.0
68	15-APR-87	4.9	0.012589	4.74	0.018197	0.000711	0.03952	7.3
69	16-APR-87	5.0	0.010000	4.88	0.013183	0.000711	0.04368	7.1
70	17-APR-87	4.9	0.012589	4.96	0.010965	0.000711	0.03952	7.0
71	18-APR-87	4.9	0.012589	4.66	0.021878	0.000711	0.03952	7.0
72	19-APR-87	5.0	0.010000	4.62	0.023988	0.000711	0.03952	6.4
73	20-APR-87	4.9	0.012589	4.84	0.014454	0.000711	0.03952	6.6
74	21-APR-87			4.87	0.013490	0.000711	0.04784	6.5
75	22-APR-87			4.82	0.015136	0.000711	0.04160	6.2
76	23-APR-87			4.74	0.018197	0.000711	0.04160	6.2
77	24-APR-87			4.60	0.025119	0.000711	0.03952	6.1
78	25-APR-87			4.98	0.010471	0.000711	0.03952	6.3
79	26-APR-87			4.76	0.017378	0.000711	0.03952	5.9
80	27-APR-87			4.88	0.013183	0.000711	0.03952	5.9
81	28-APR-87			4.95	0.011220	0.000711	0.03952	5.9
82	29-APR-87			4.90	0.012589	0.000711	0.03952	6.2
83	30-APR-87			4.78	0.016596	0.000711	0.04160	6.4
84	01-MAY-87			4.76	0.017378	0.000711	0.03952	6.7
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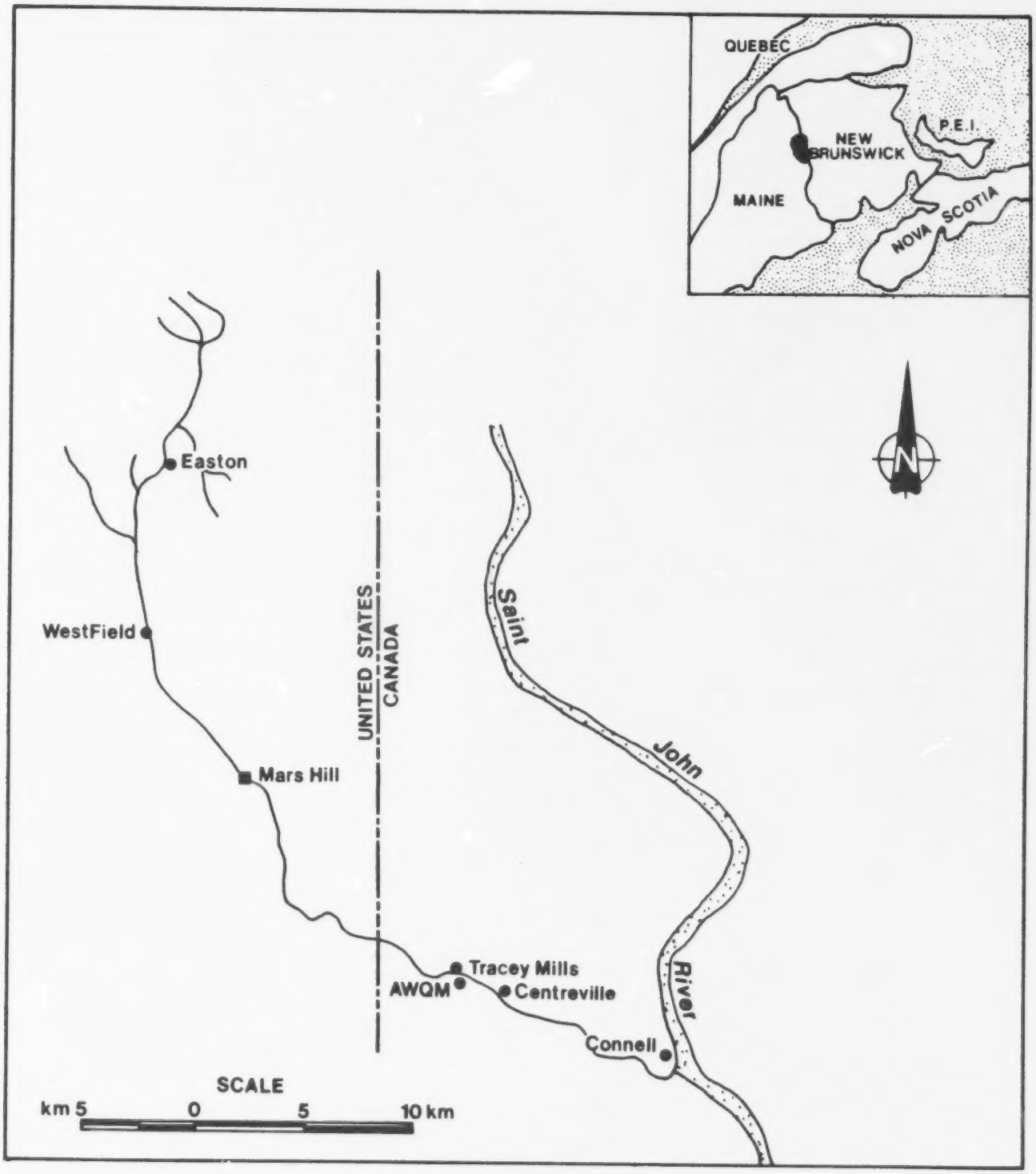
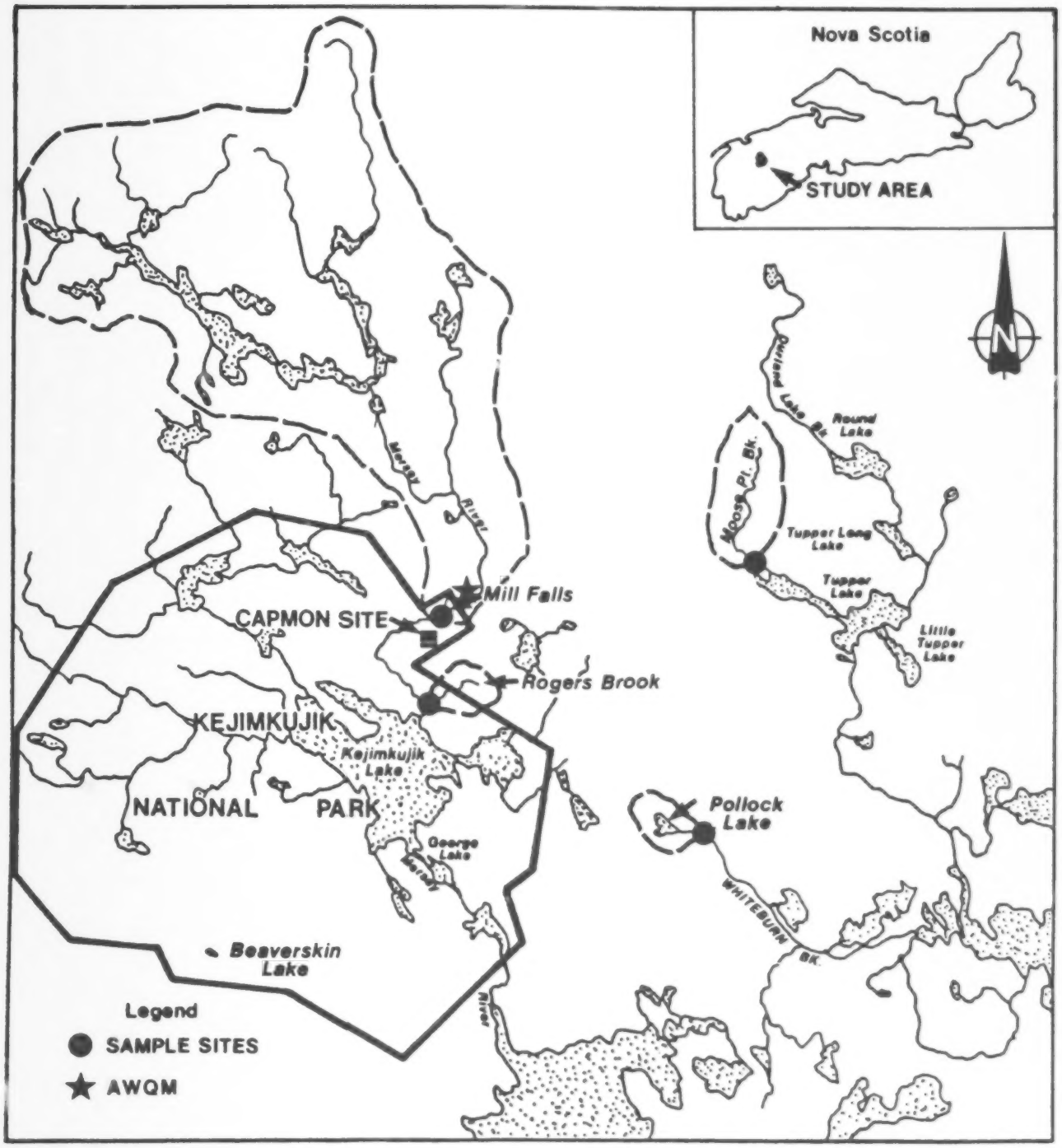


Fig. 1 The study site of Big Presque Isle Stream at Tracey Mills, New Brunswick



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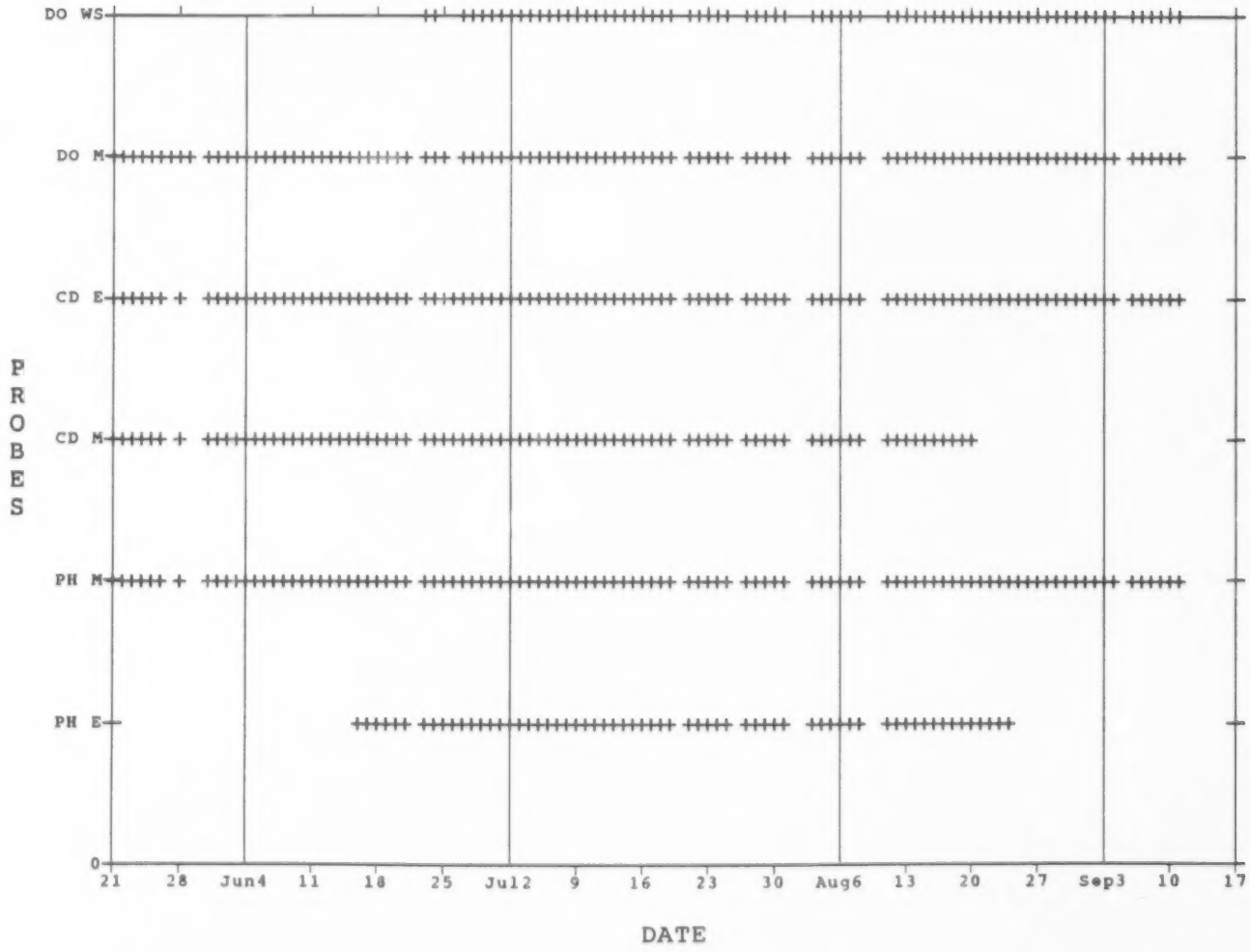

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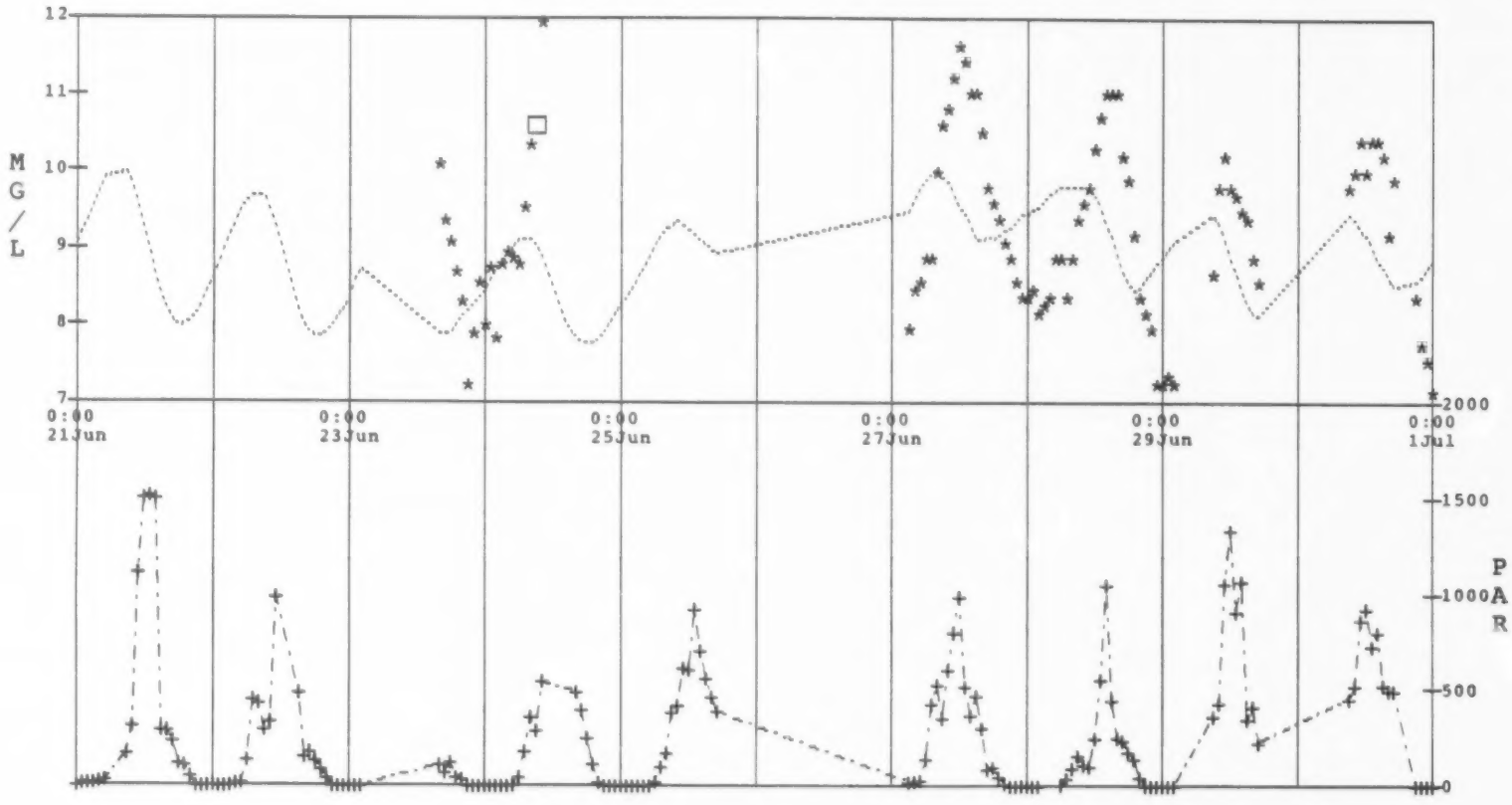

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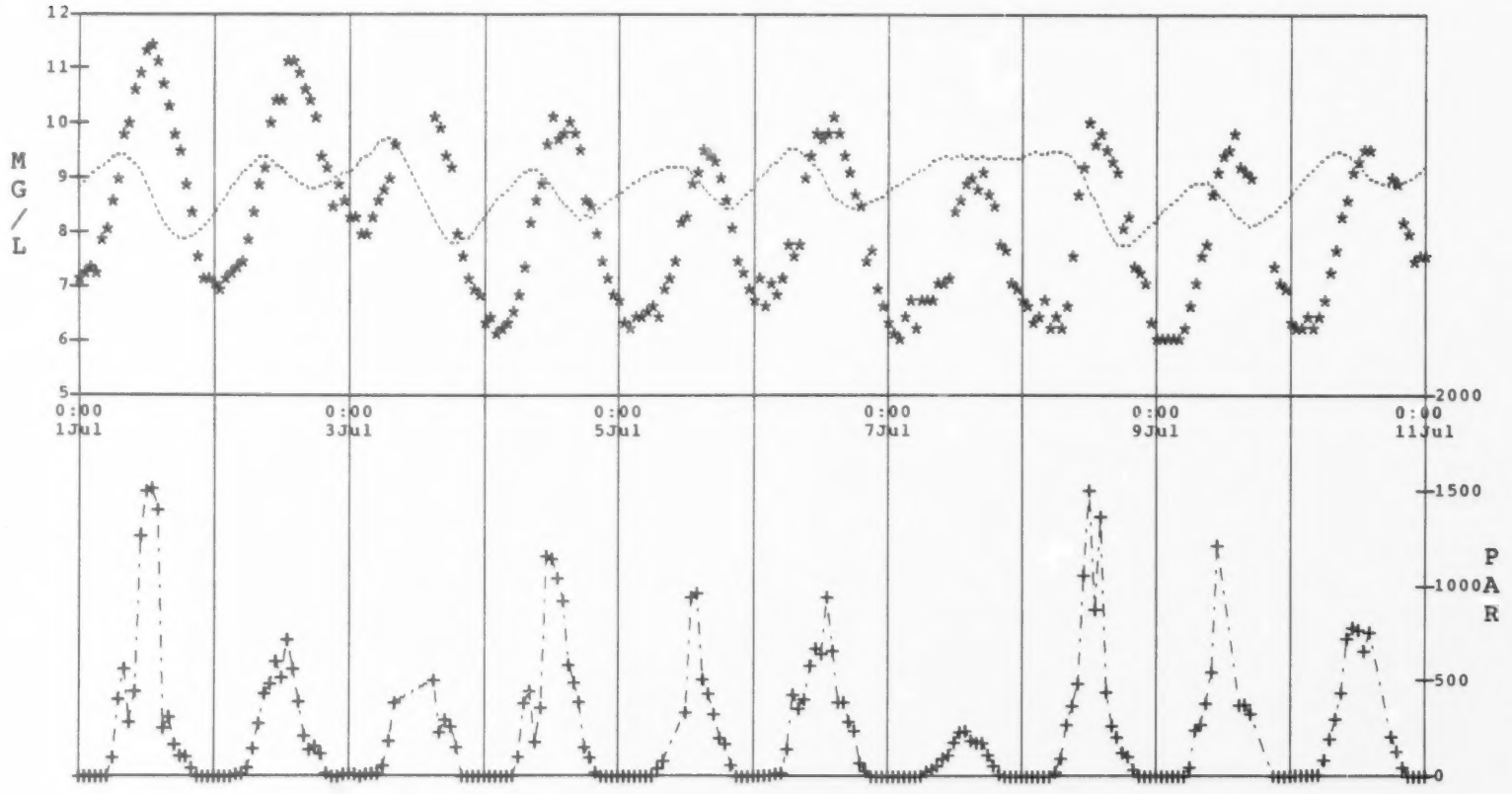

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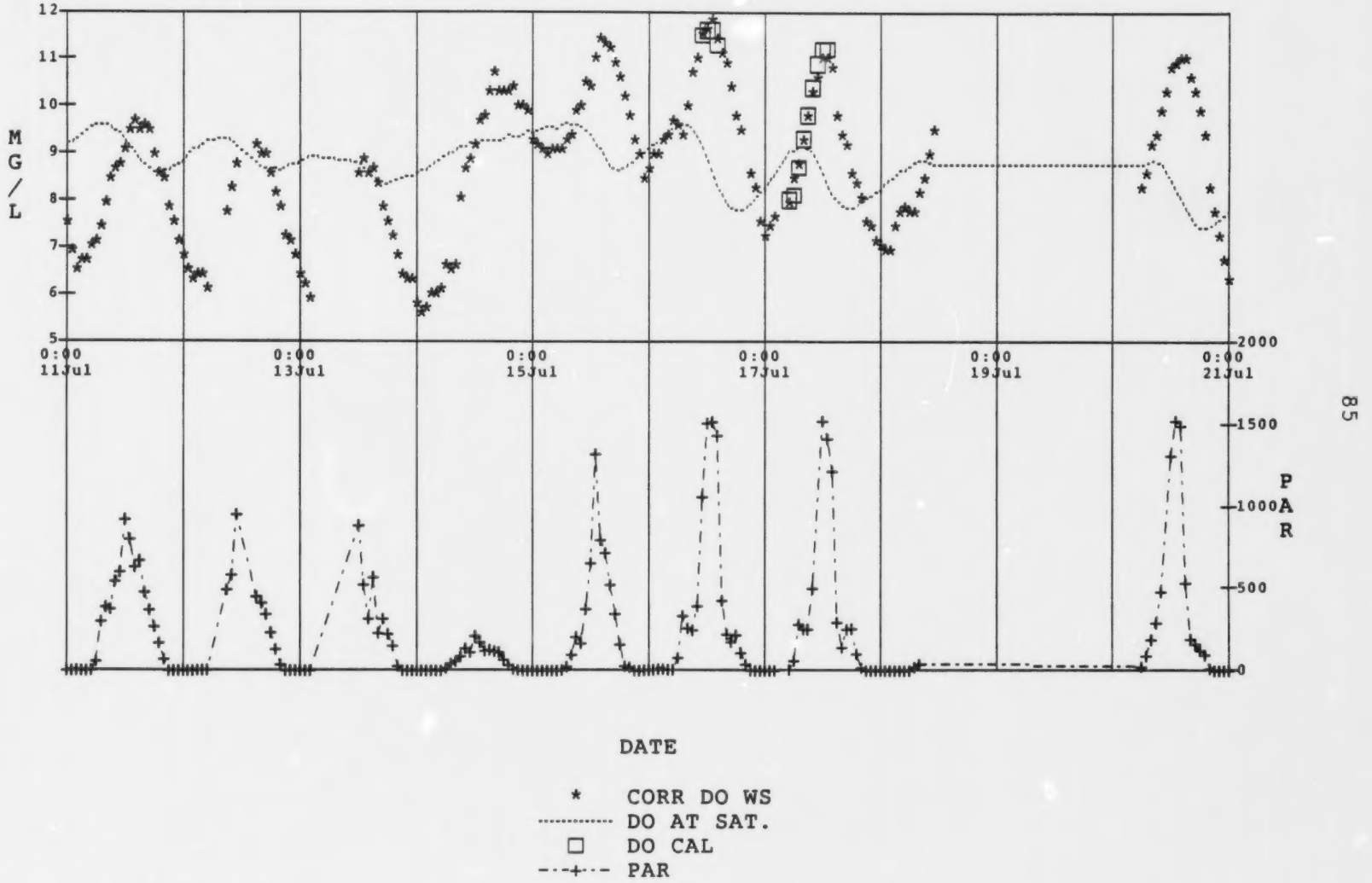

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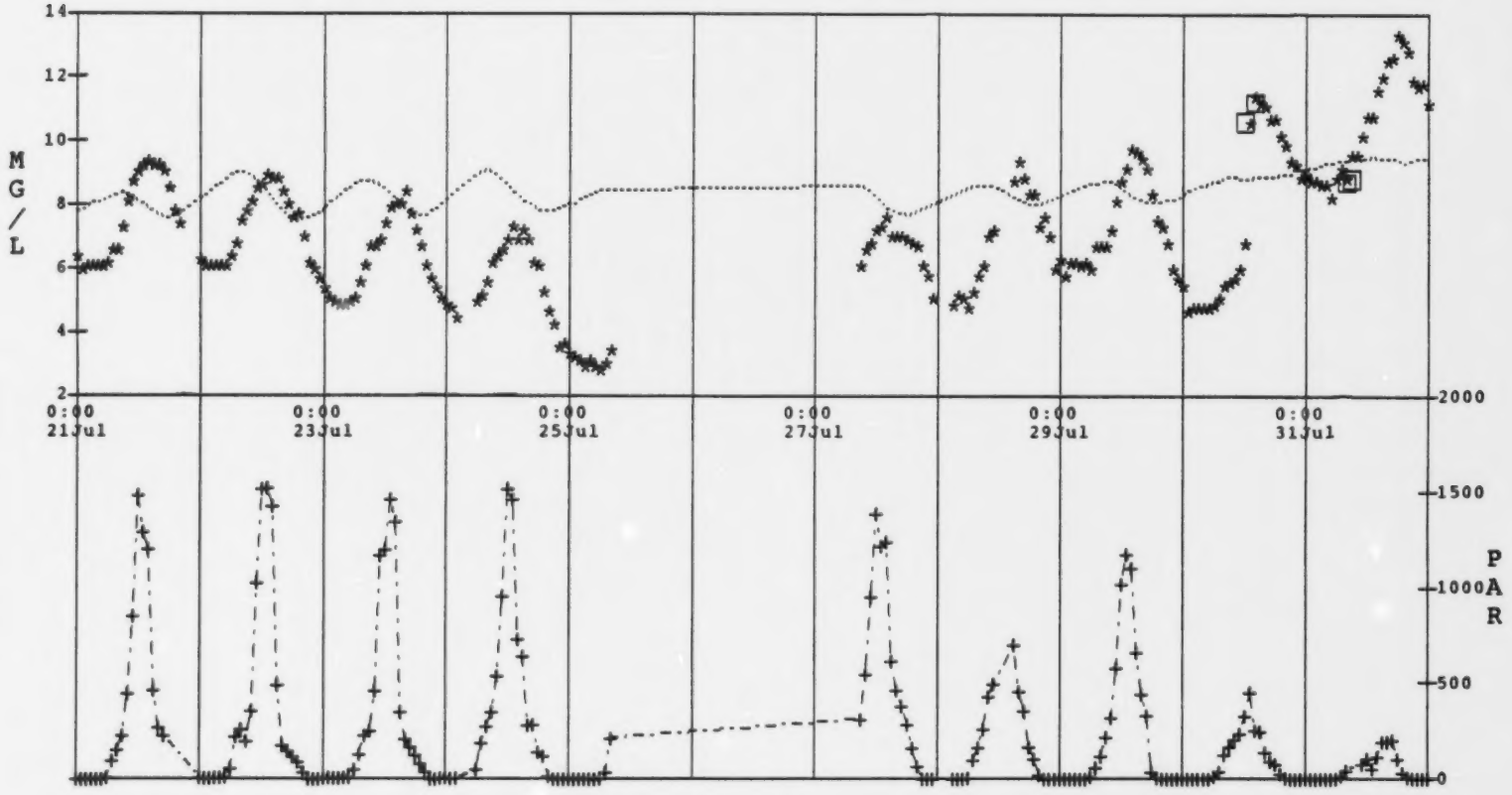

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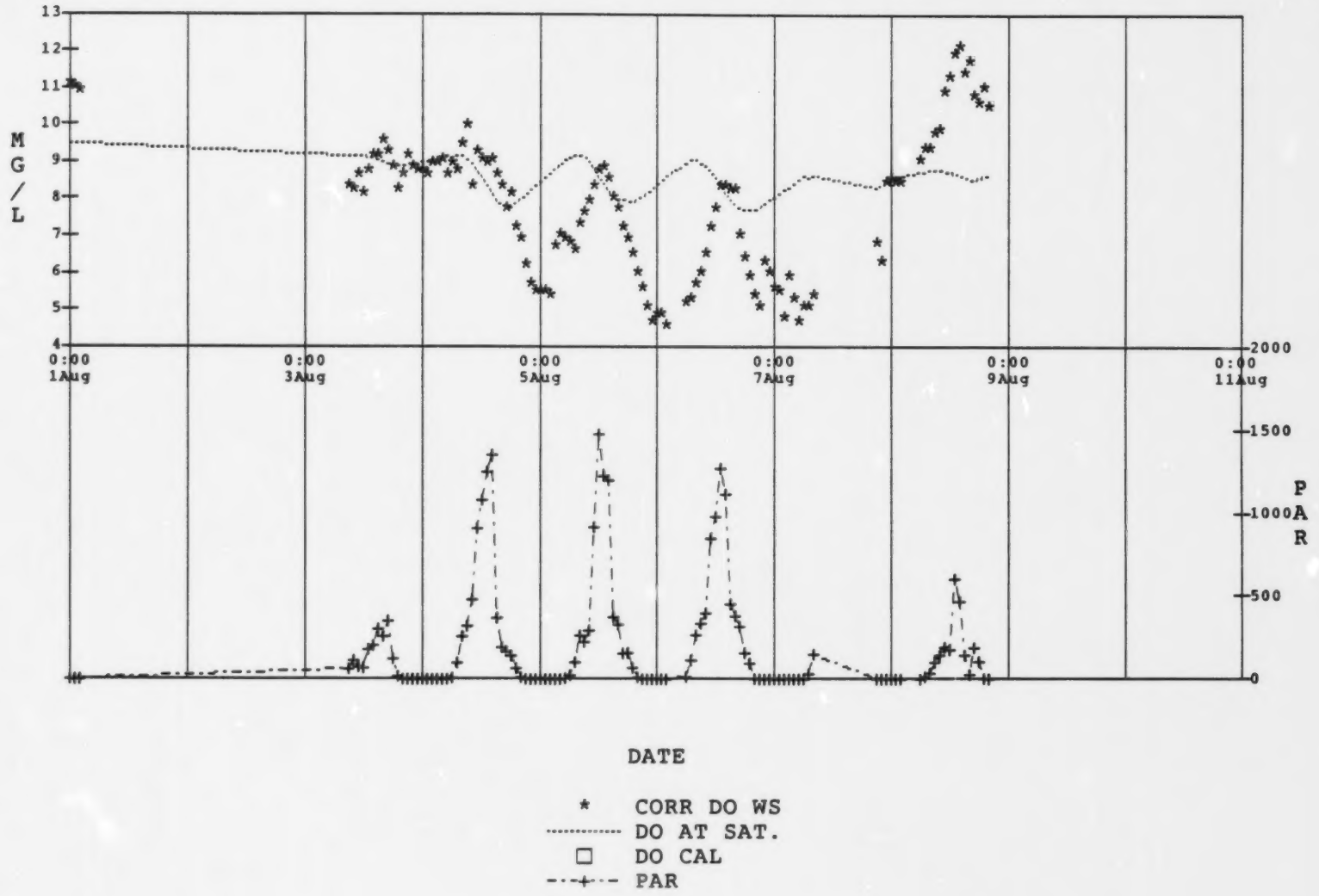

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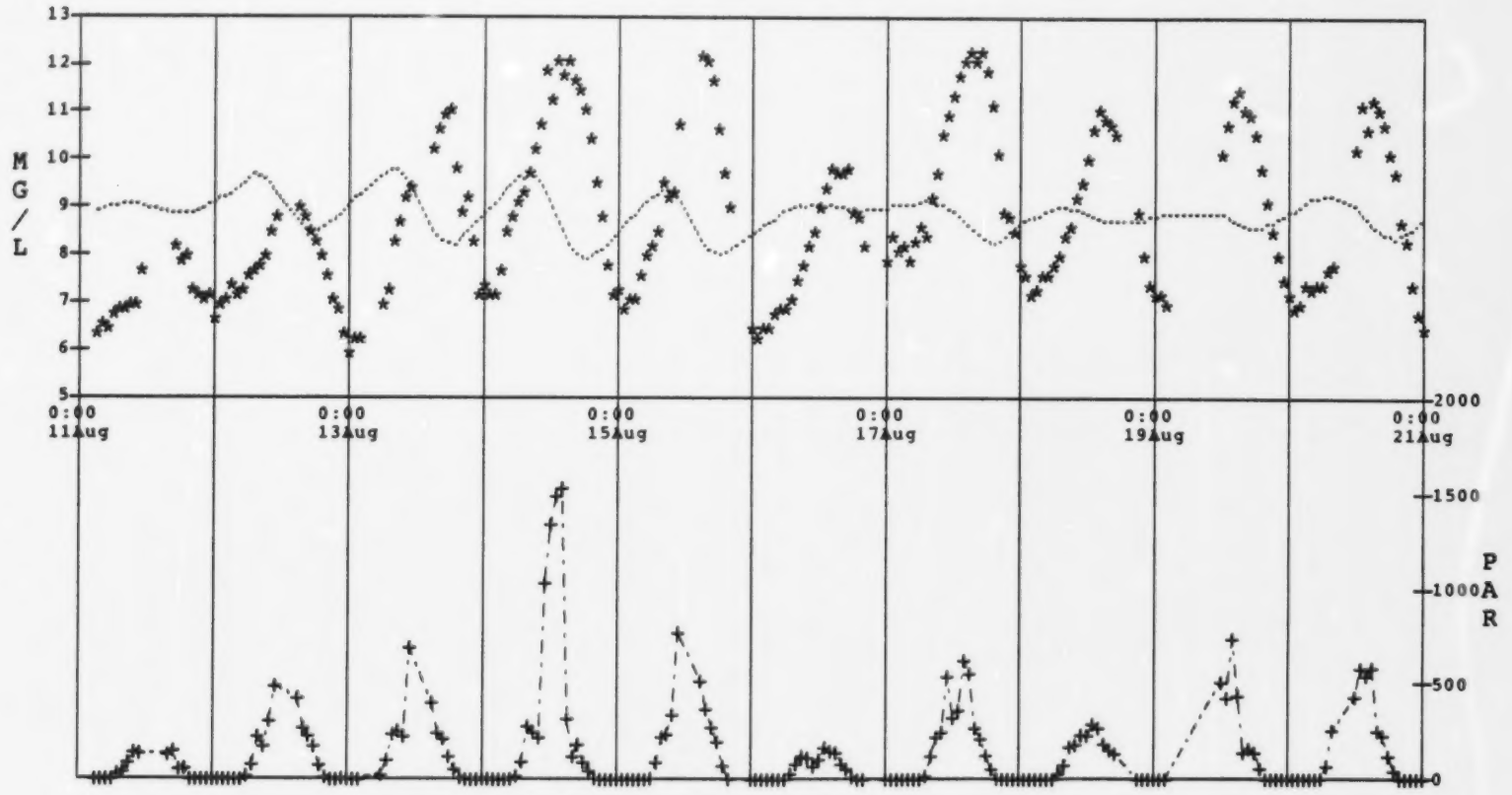

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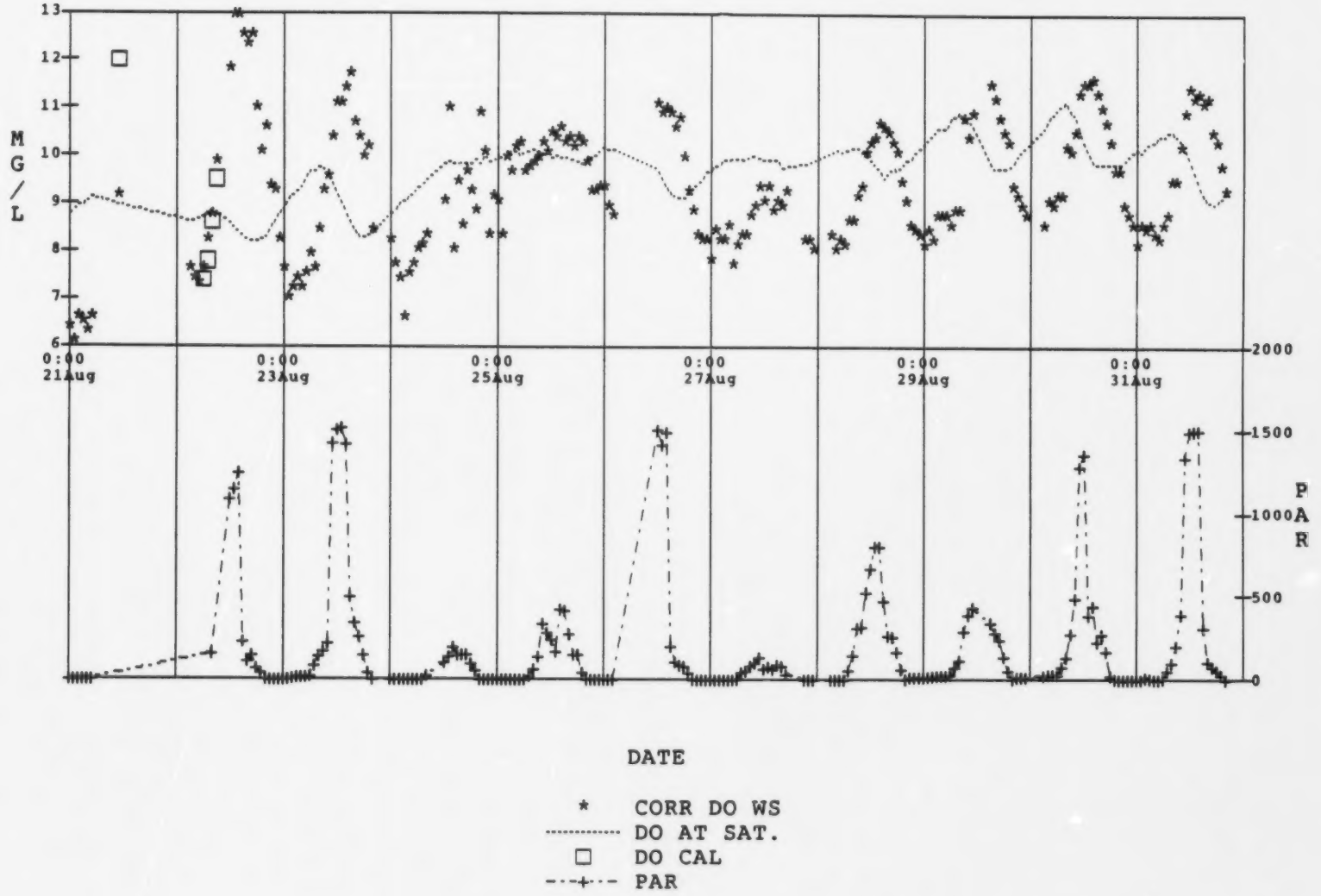

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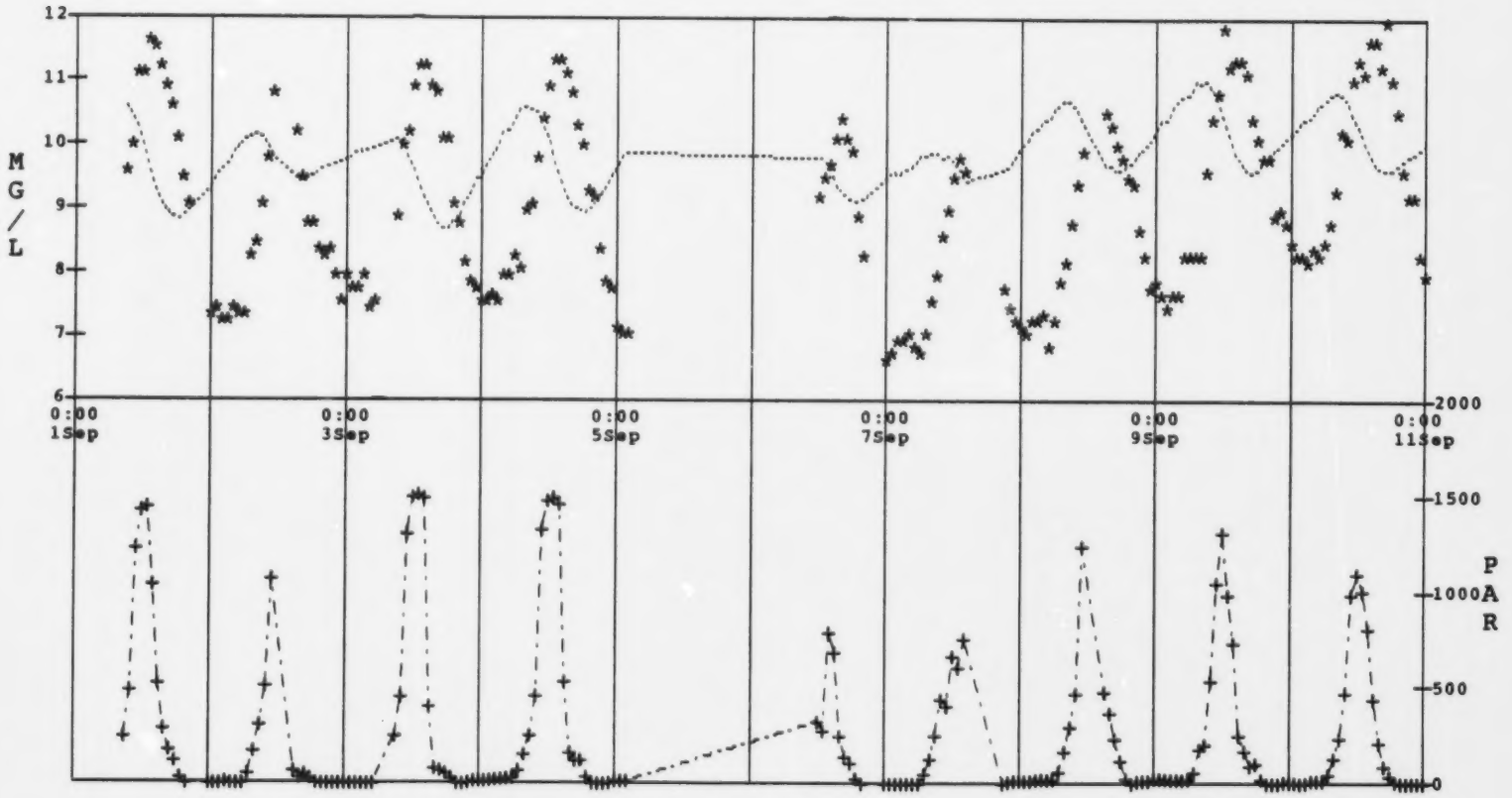

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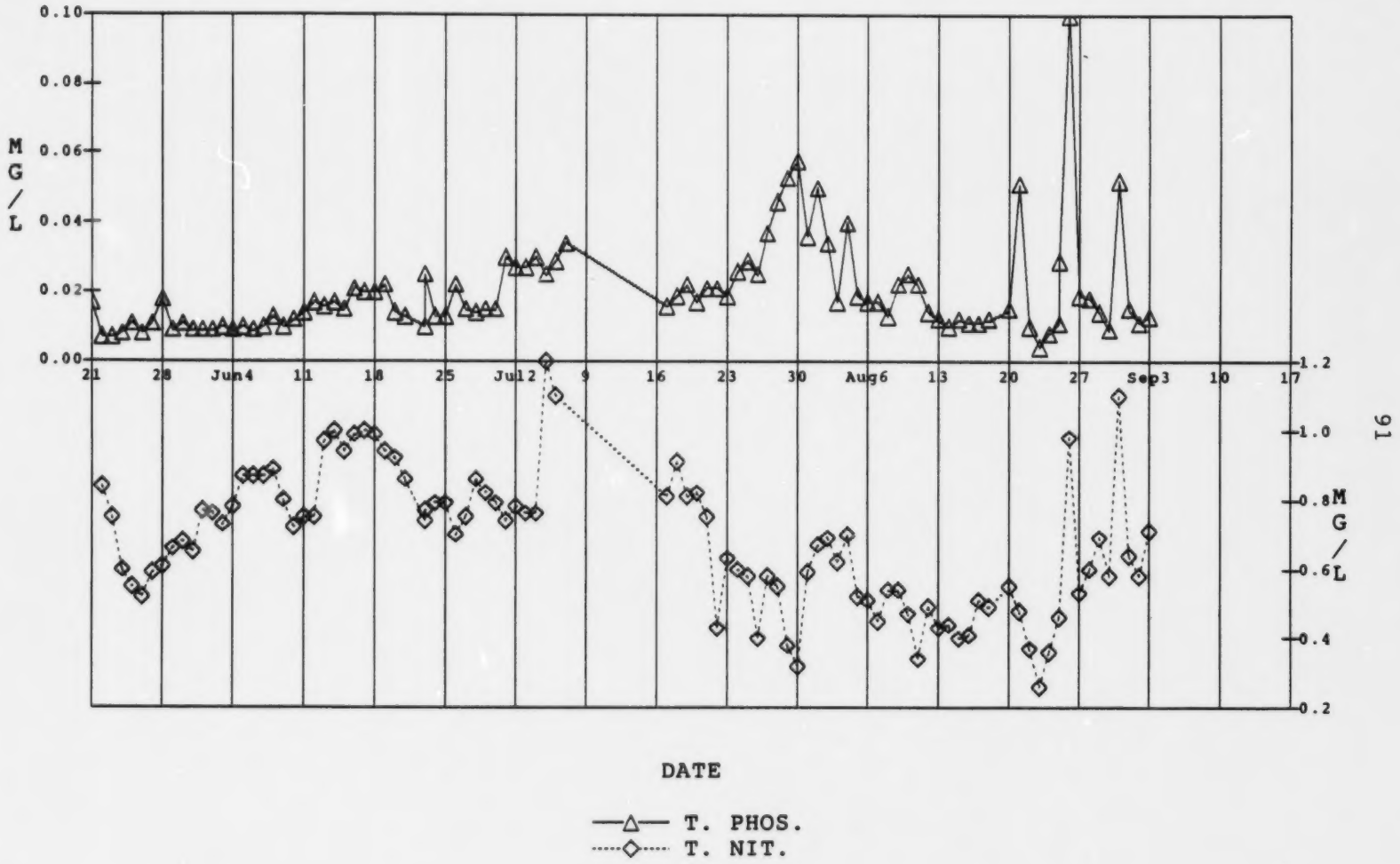

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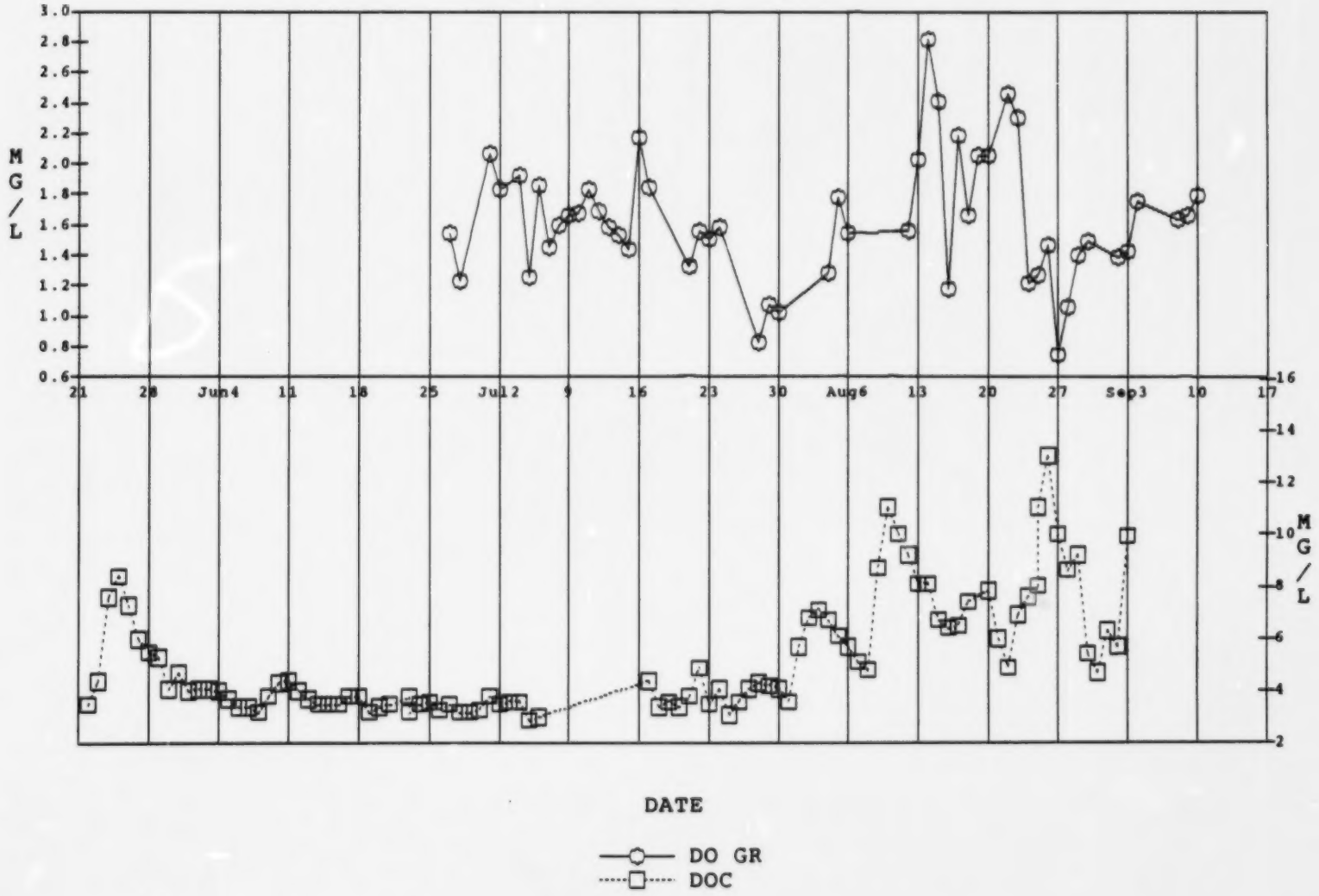

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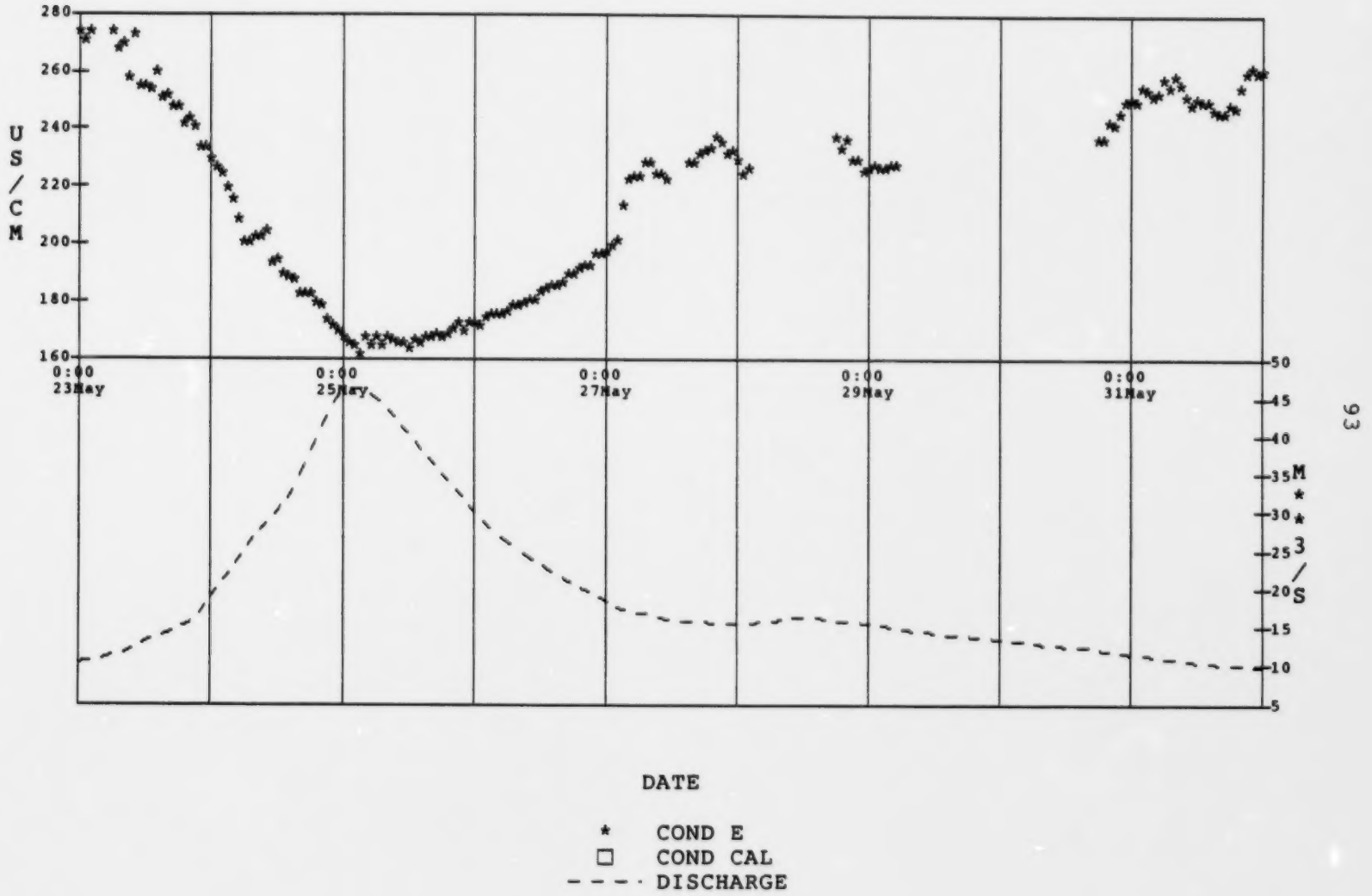


FIG. 15 SPECIFIC CONDUCTANCE AND DISCHARGE VALUES IN THE BIG PRESQUE ISLE STREAM DURING JUNE 1-10 1986

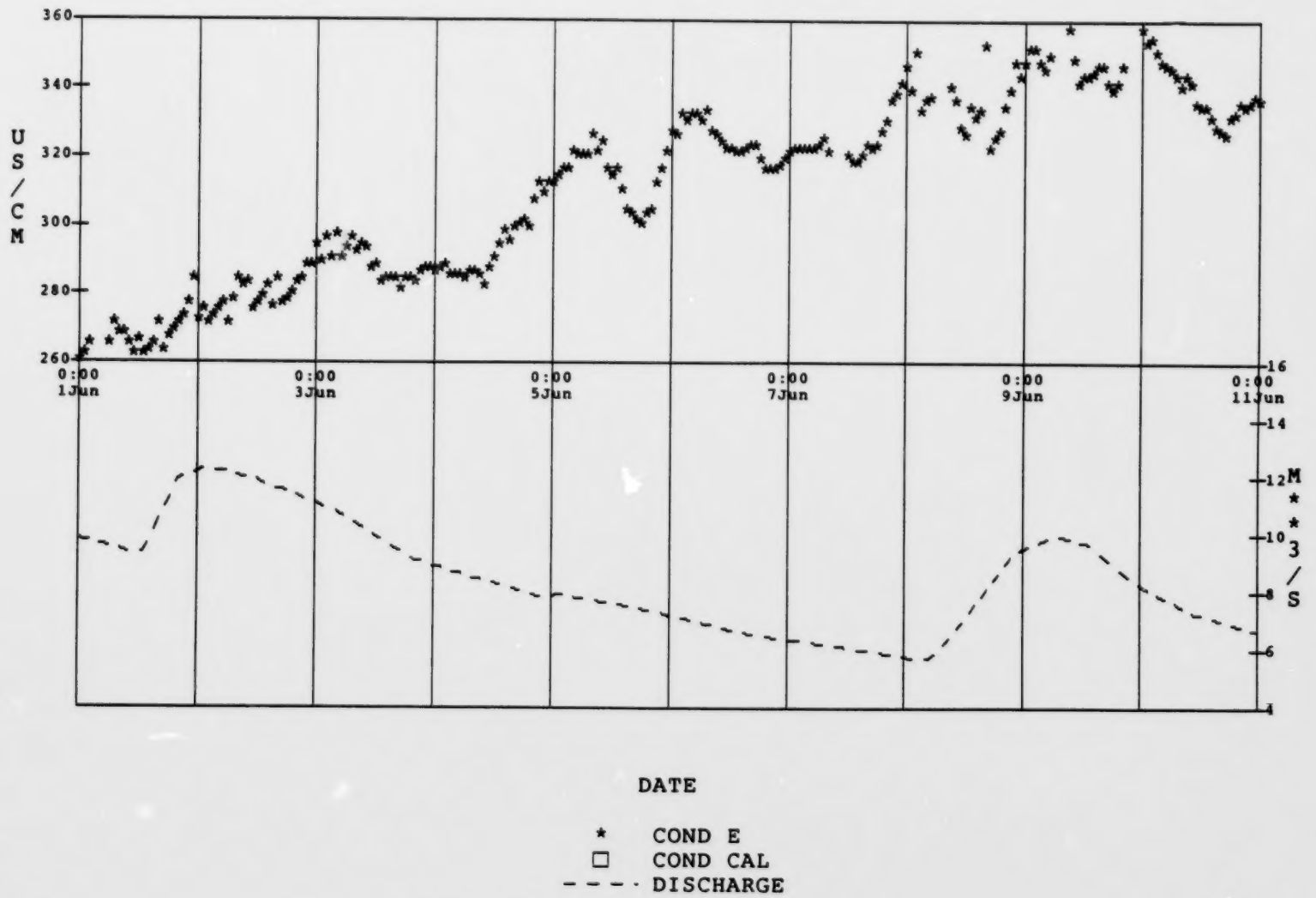
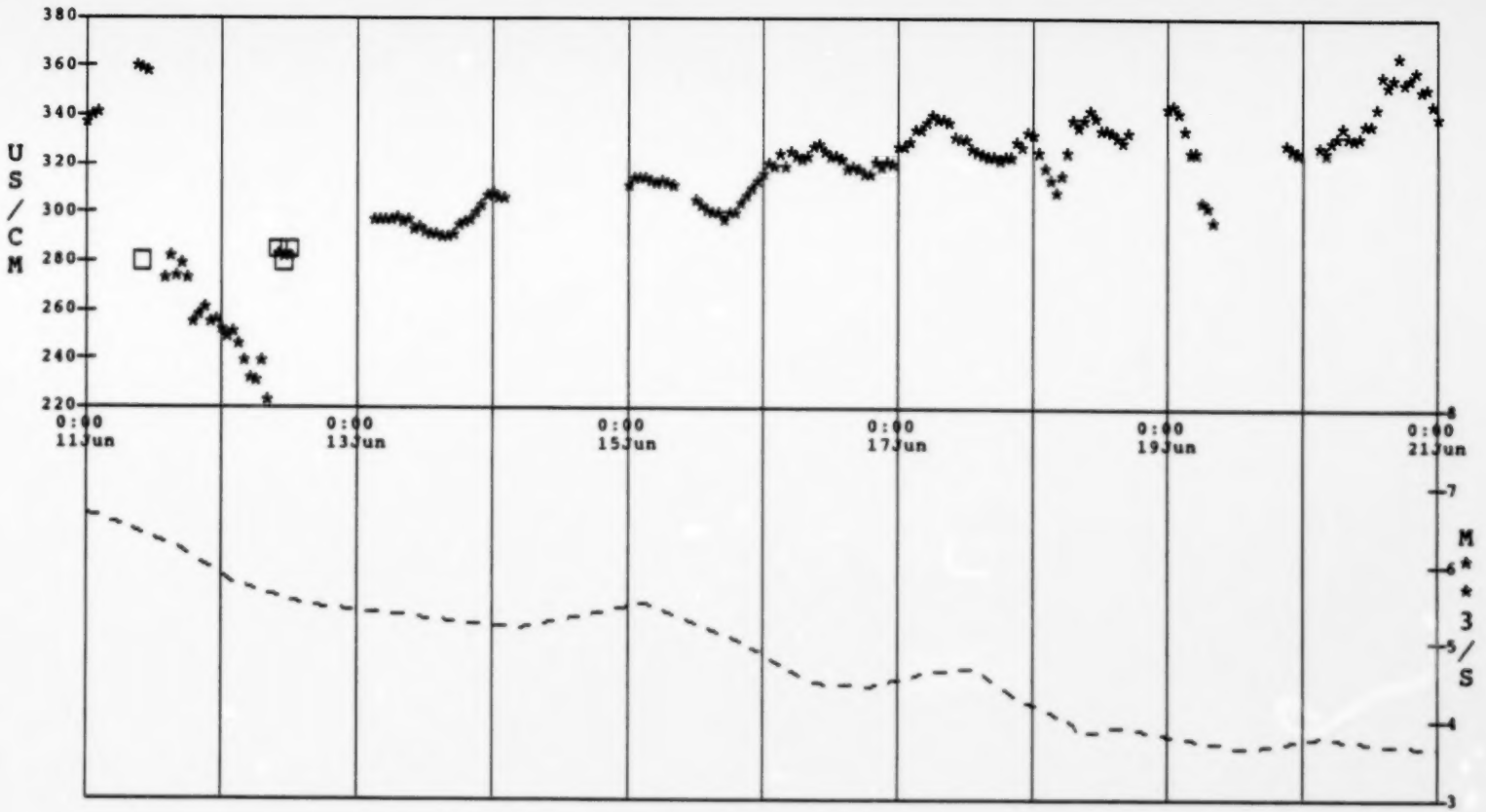


FIG. 16 SPECIFIC CONDUCTANCE AND DISCHARGE VALUES IN THE BIG PRESQUE ISLE STREAM DURING JUNE 11-20 1986



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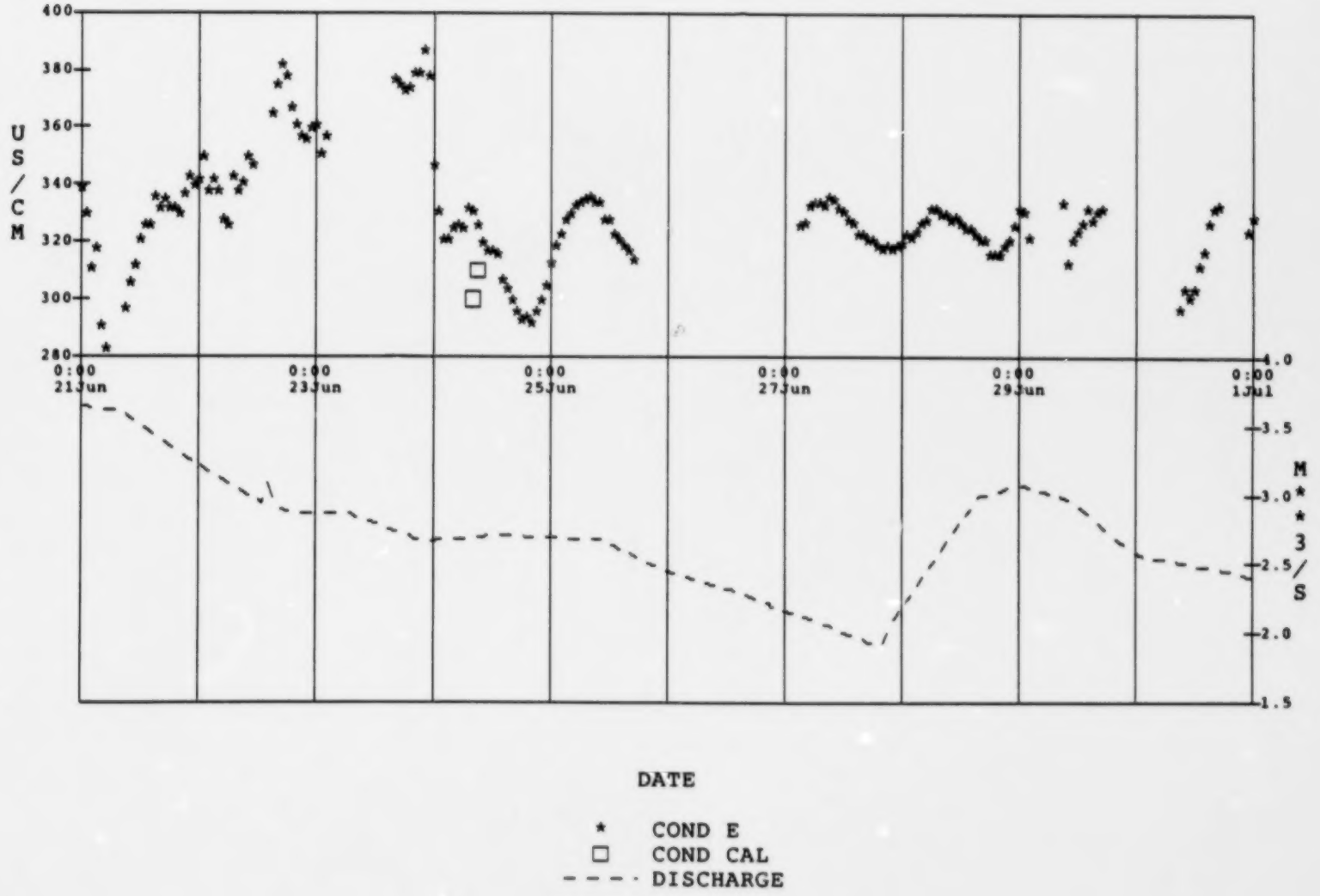

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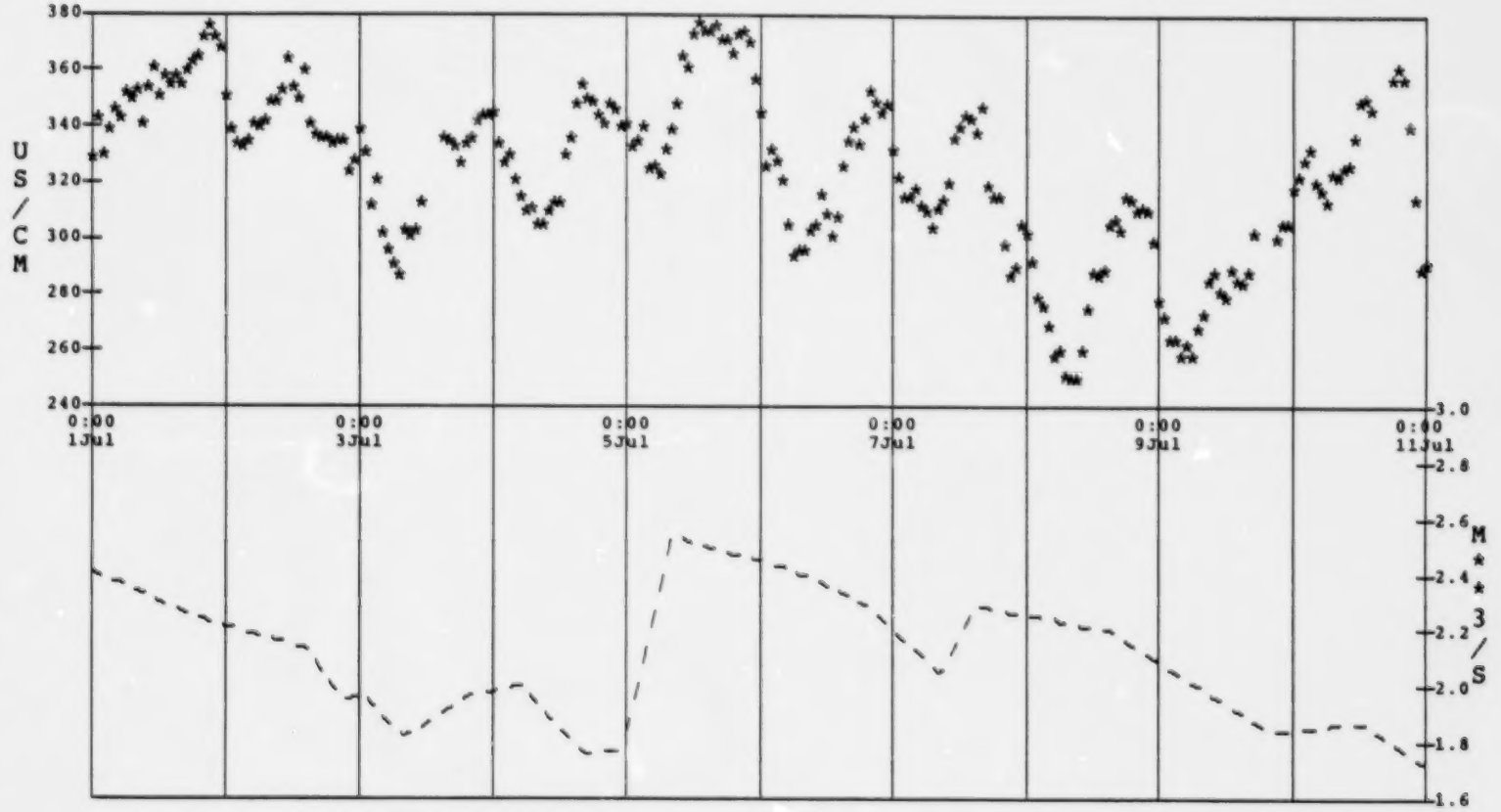

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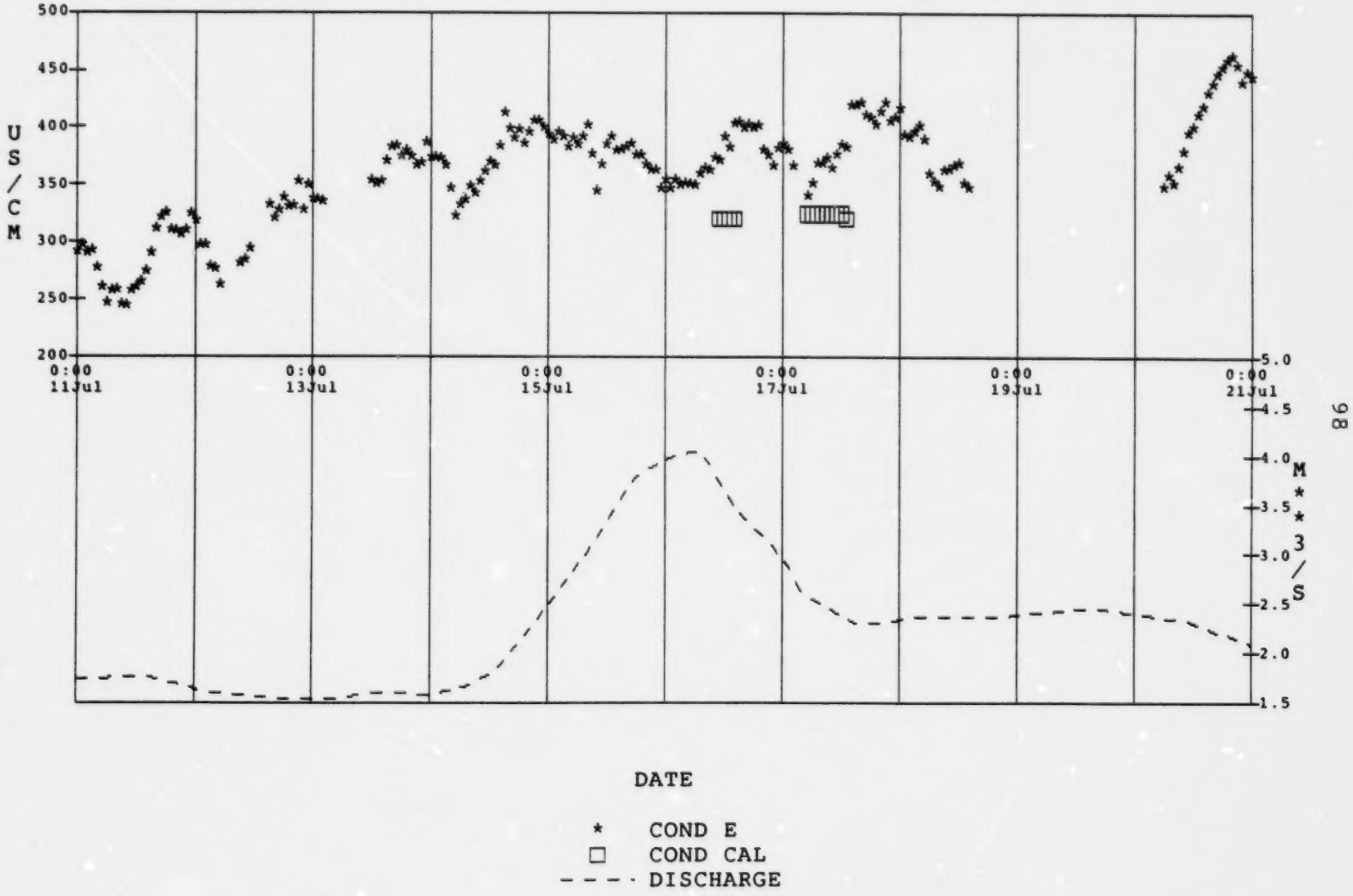

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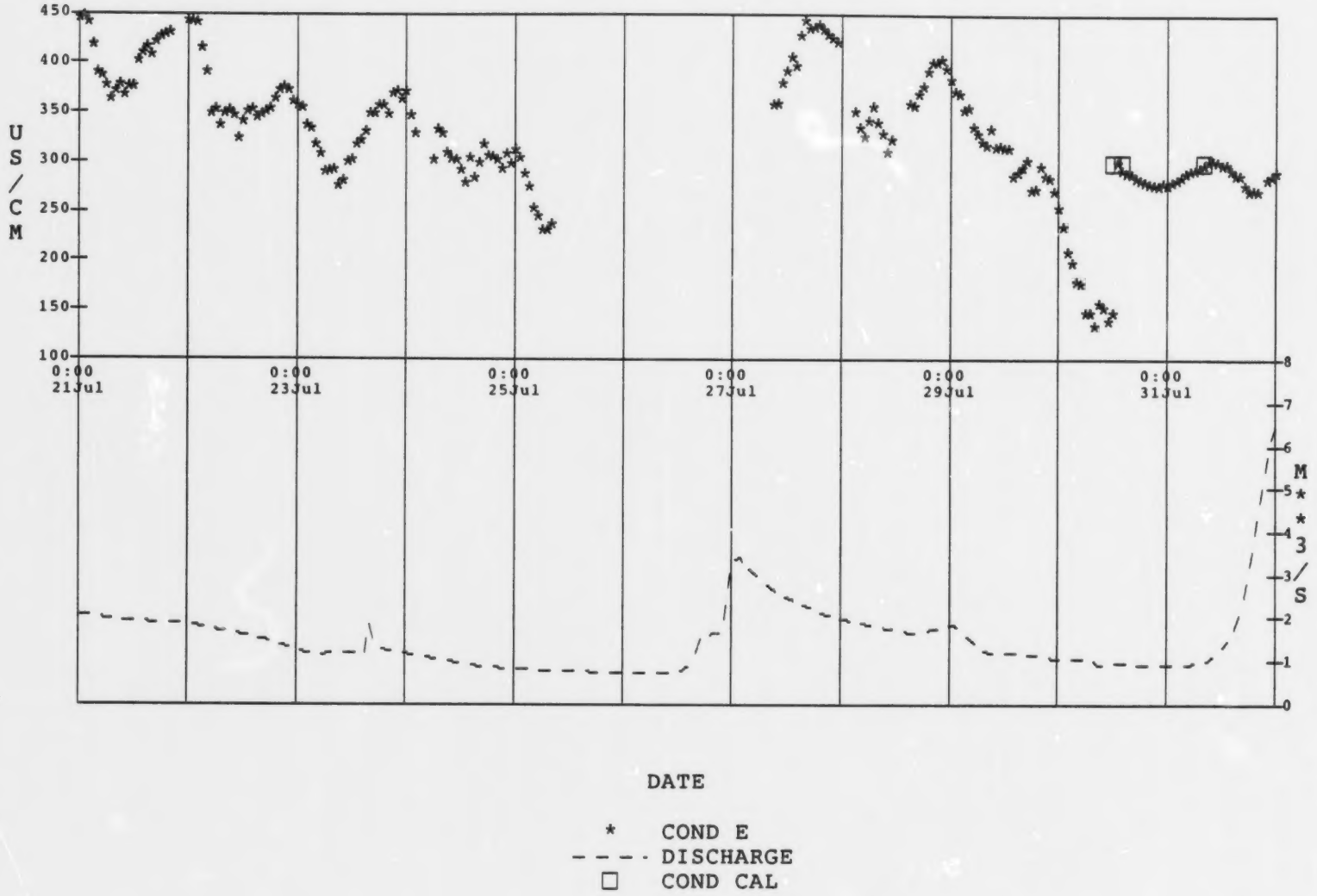


FIG. 21 SPECIFIC CONDUCTANCE AND DISCHARGE VALUES IN THE BIG PRESQUE ISLE STREAM DURING AUGUST 1-10 1986

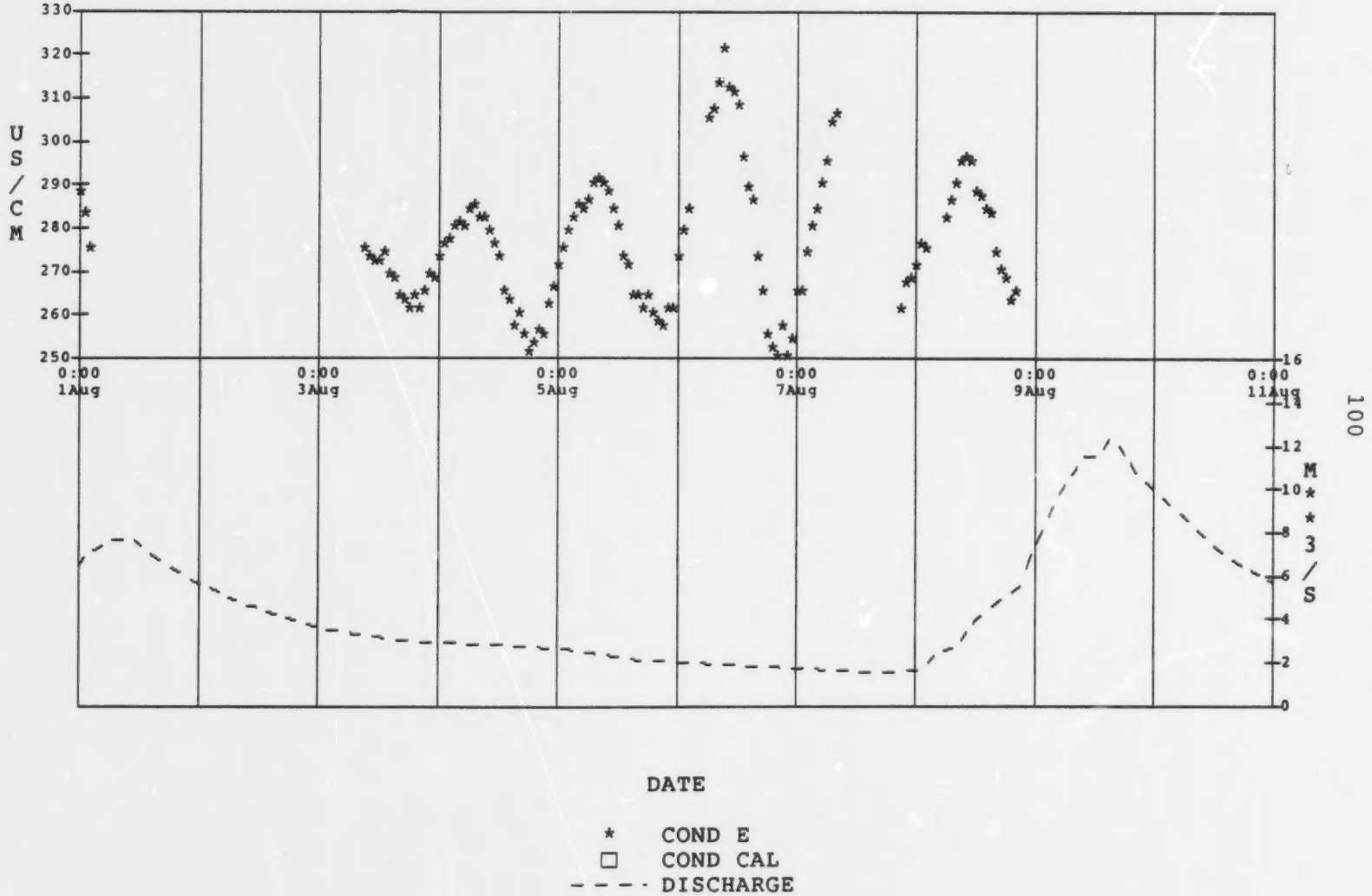
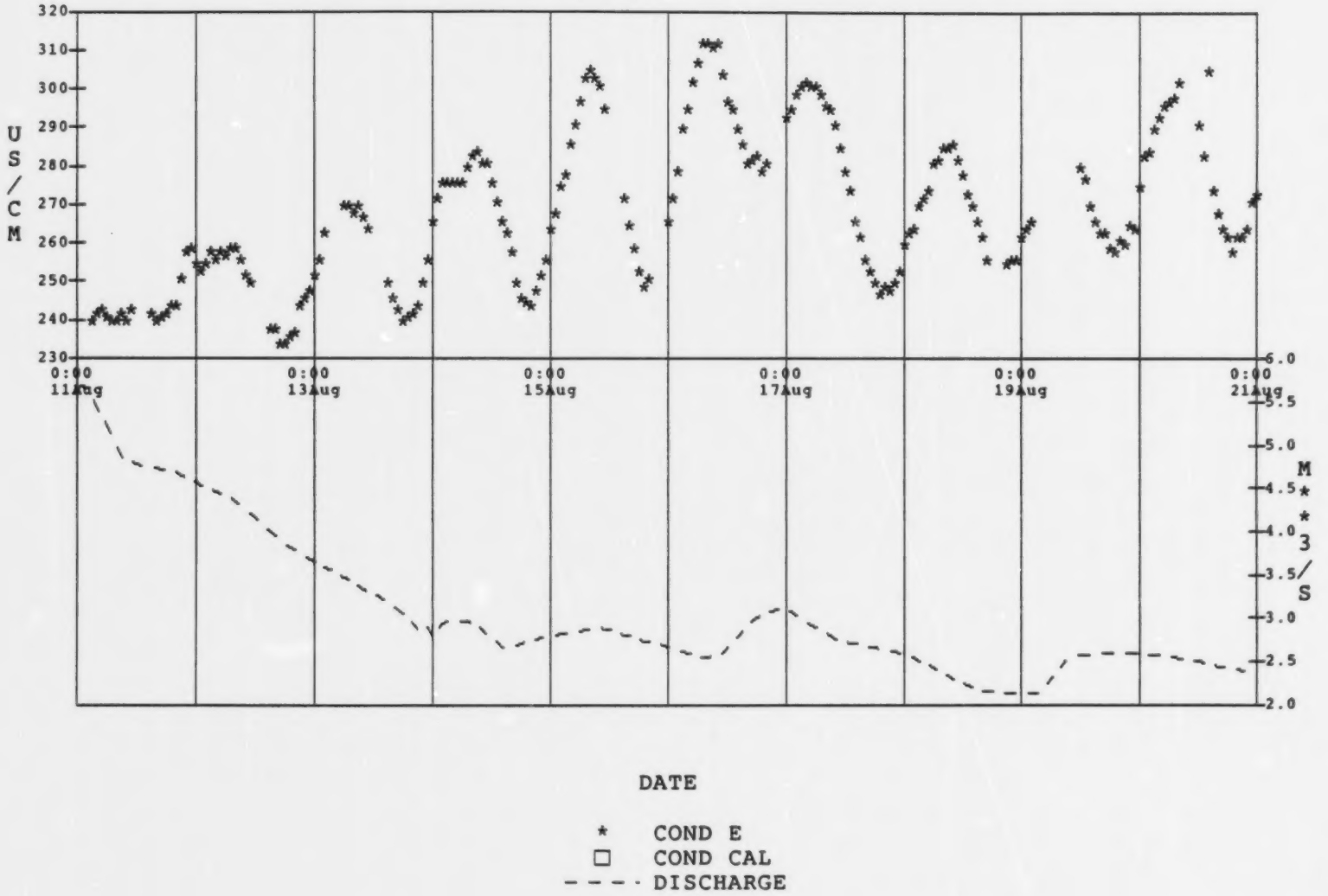


FIG. 22 SPECIFIC CONDUCTANCE AND DISCHARGE VALUES IN THE BIG PRESQUE ISLE STREAM DURING AUGUST 11-20 1986



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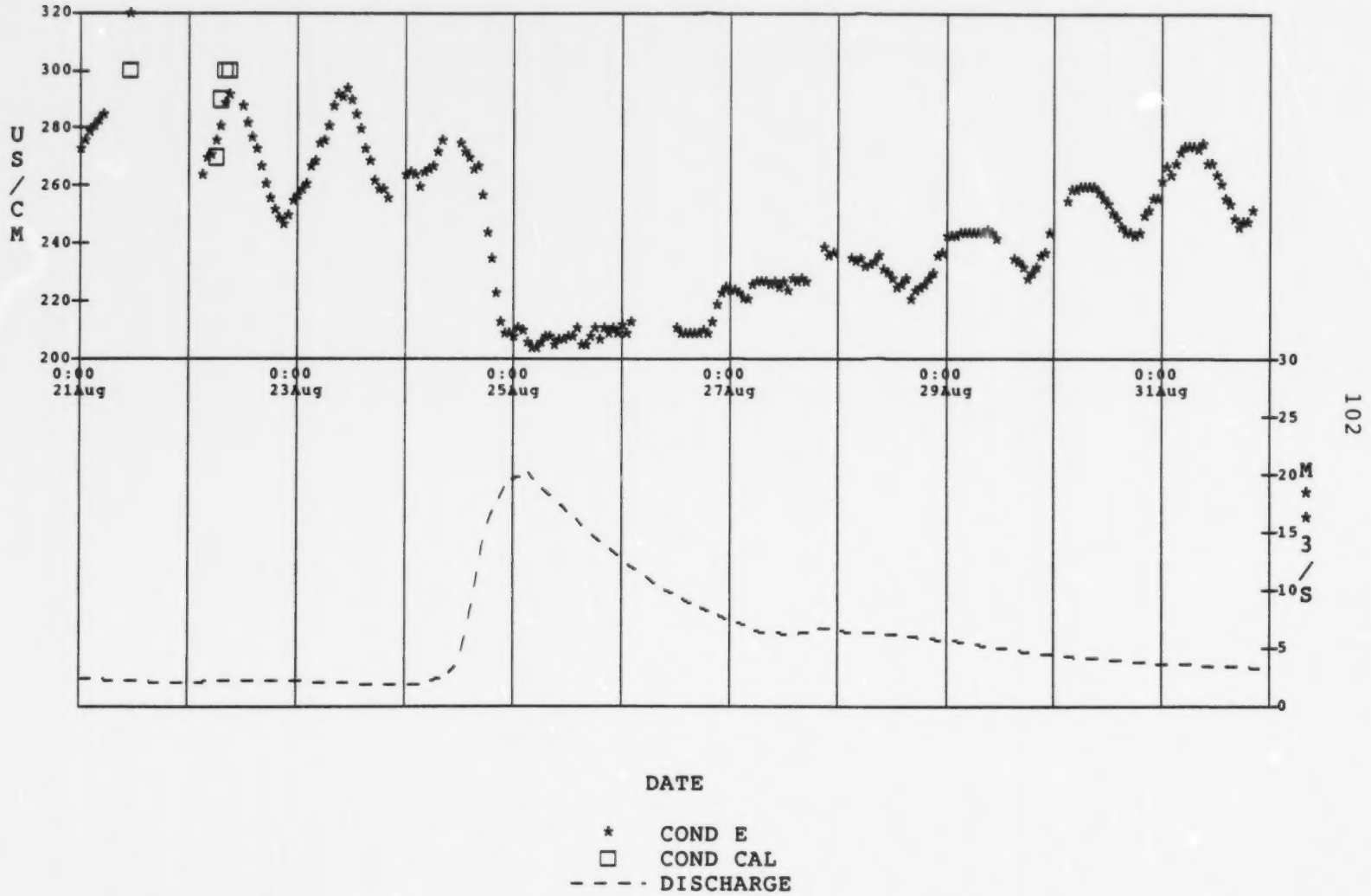


FIG. 24 SPECIFIC CONDUCTANCE AND DISCHARGE VALUES IN THE BIG PRESQUE ISLE STREAM DURING SEPTEMBER 1-11 1986

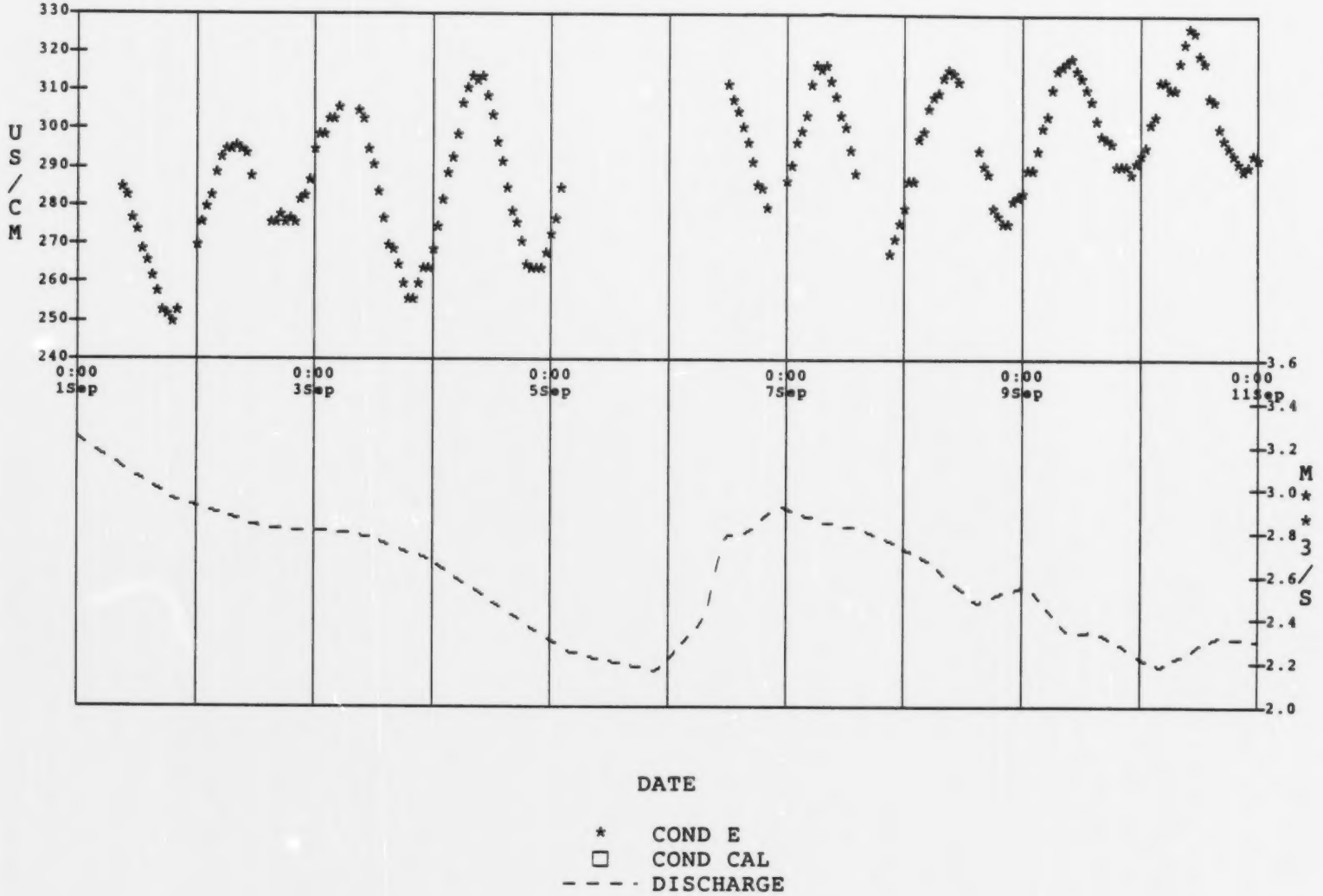
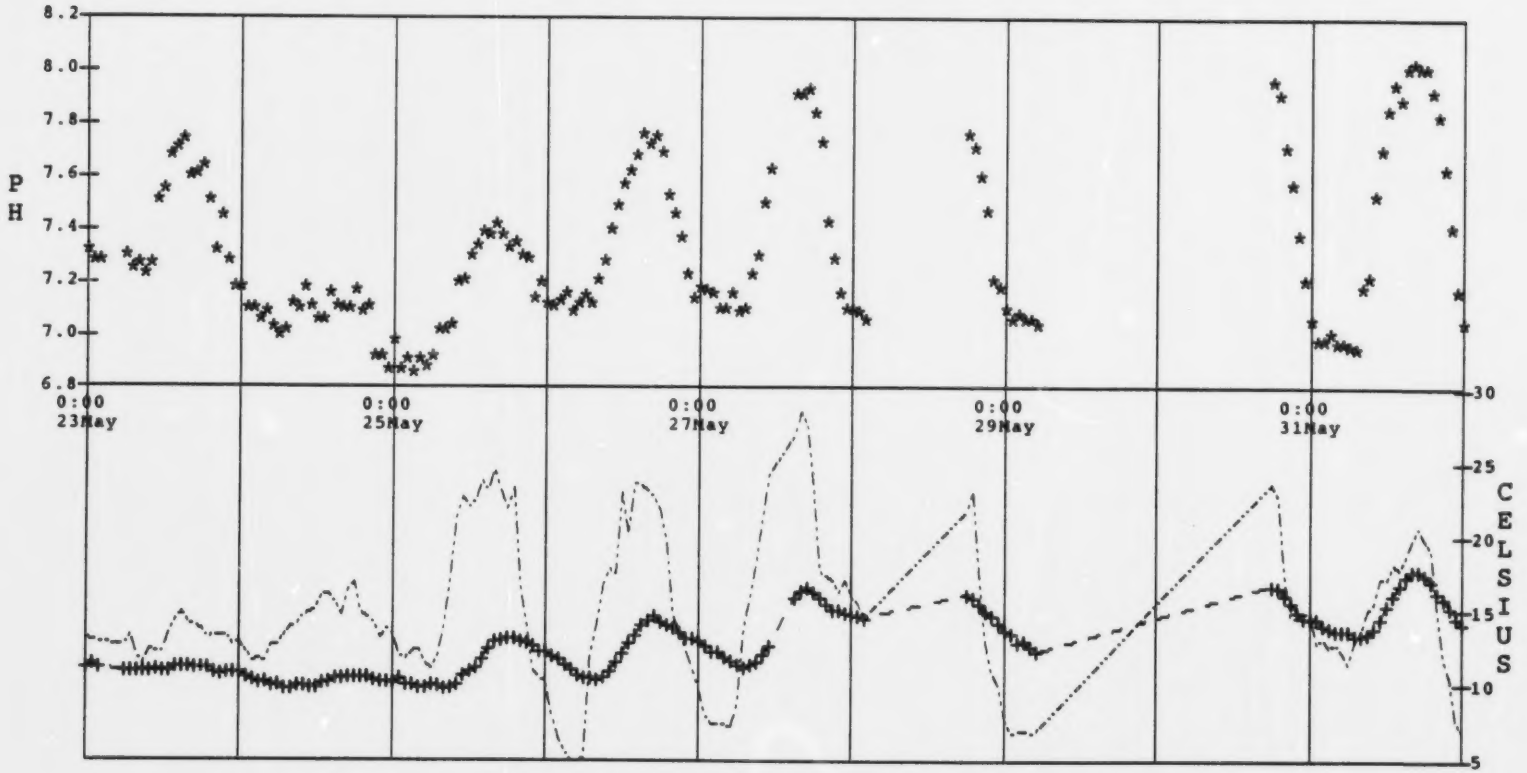


FIG. 25 PH, WATER TEMPERATURE AND AIR TEMPERATURE AT THE BIG PRESQUE ISLE STREAM DURING MAY 23-31 1986



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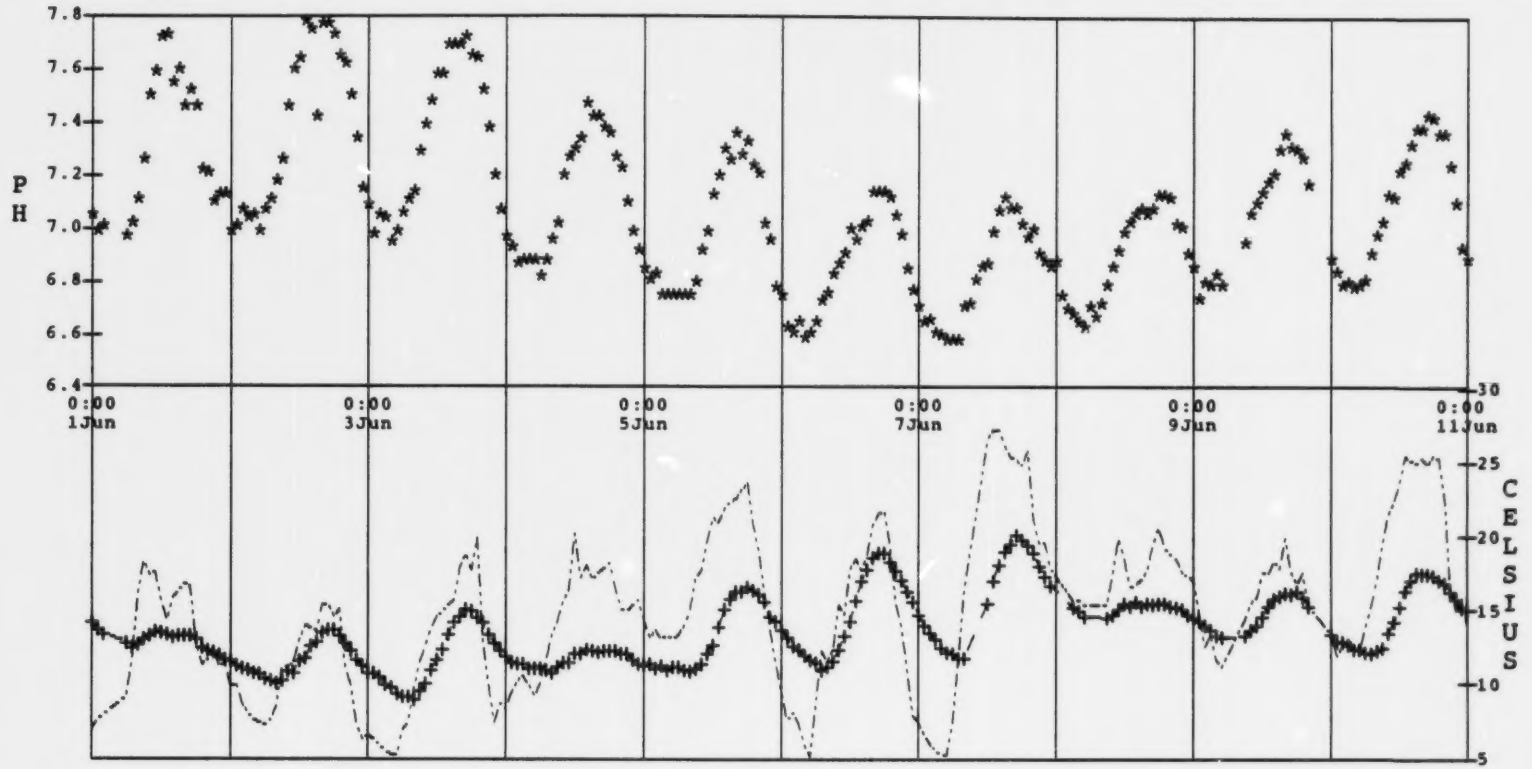


FIG. 27 PH, WATER TEMPERATURE AND AIR TEMPERATURE AT THE BIG PRESQUE ISLE STREAM DURING JUNE 11-20 1986

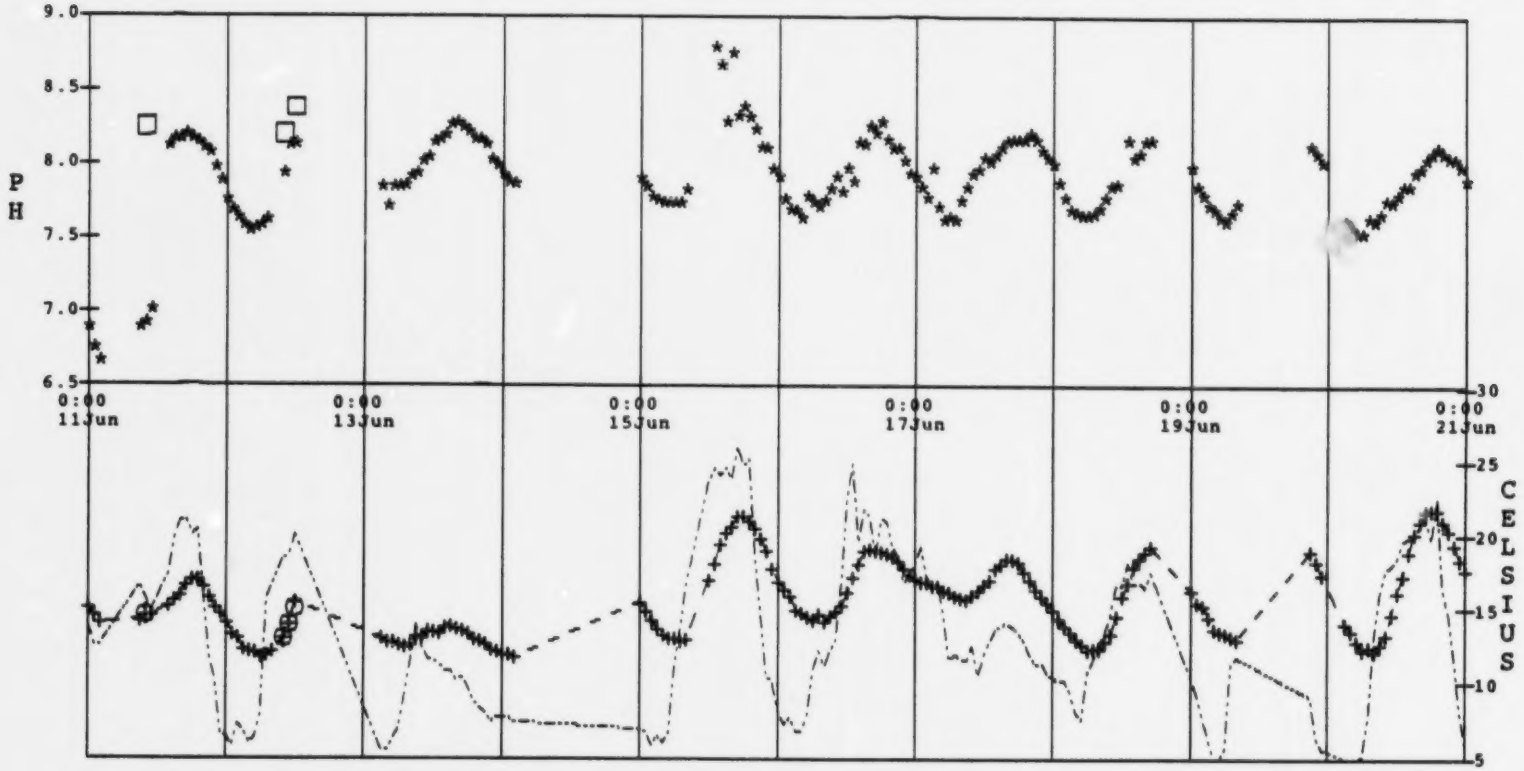


FIG. 28 PH, WATER TEMPERATURE AND AIR TEMPERATURE AT THE BIG PRESQUE ISLE STREAM DURING JUNE 21-30 1986

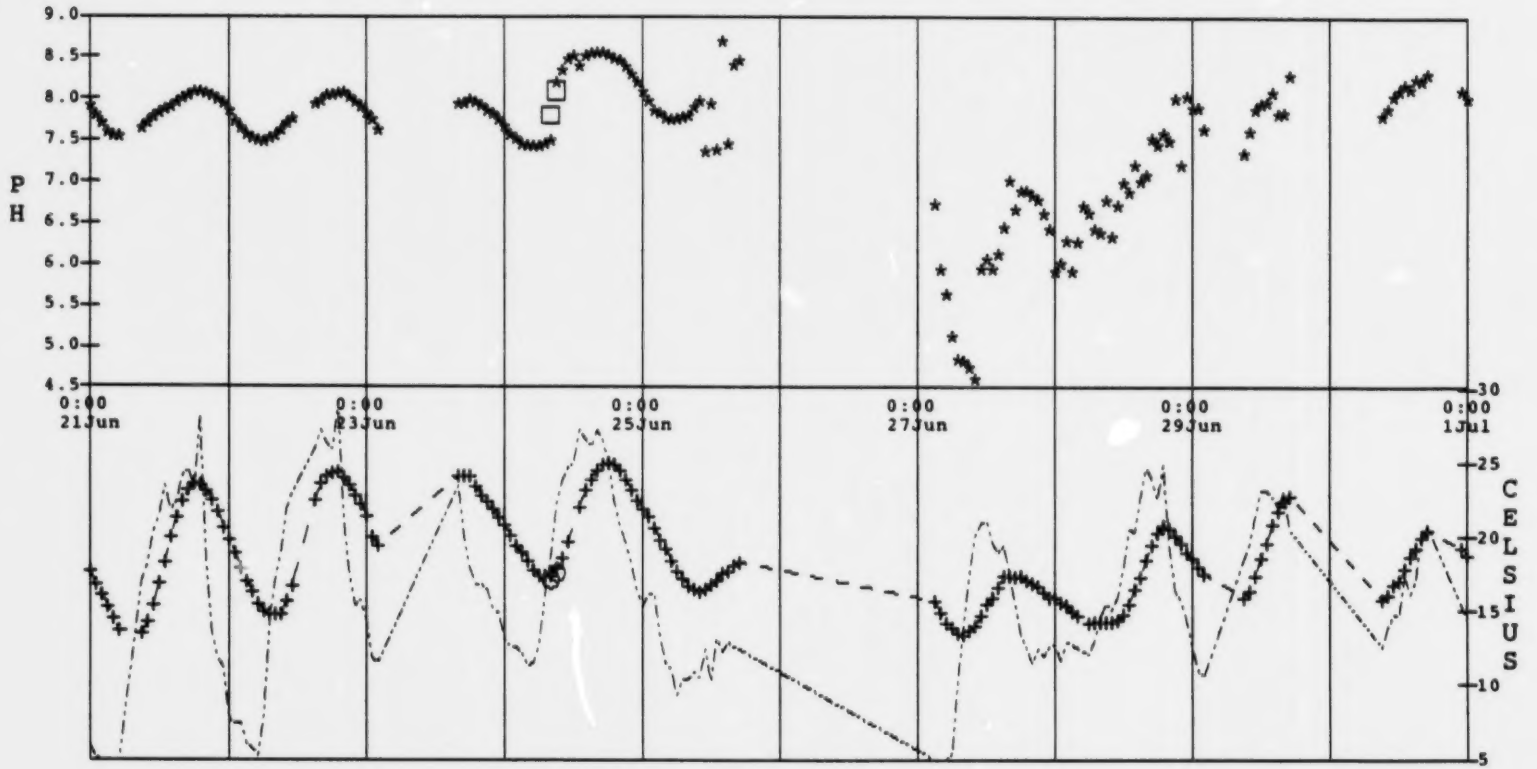


FIG. 29 PH, WATER TEMPERATURE AND AIR TEMPERATURE AT THE BIG PRESQUE ISLE STREAM DURING JULY 1-10 1986

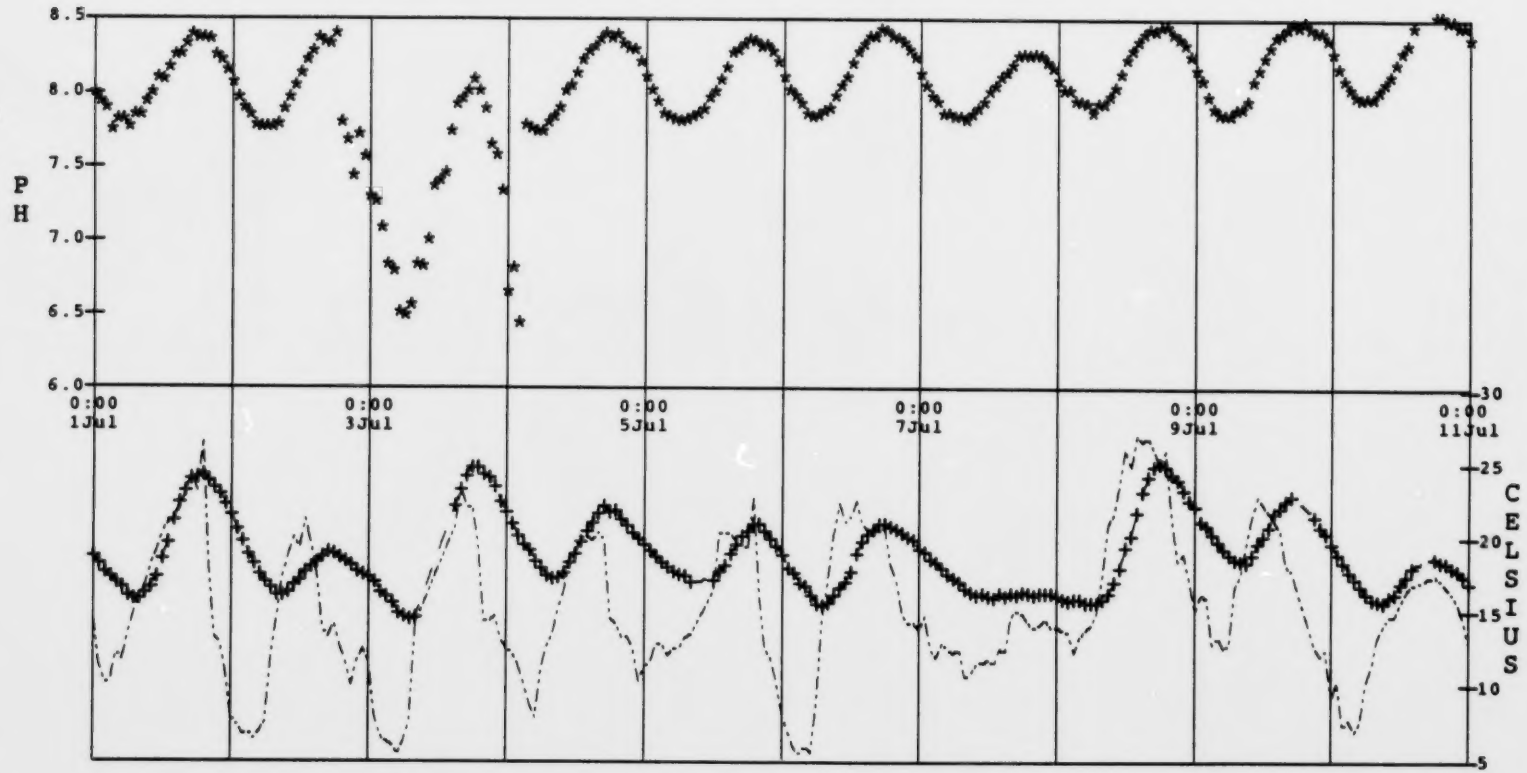


FIG. 30 PH, WATER TEMPERATURE AND AIR TEMPERATURE IN THE BIG PRESQUE ISLE STREAM DURING JULY 11-20 1986

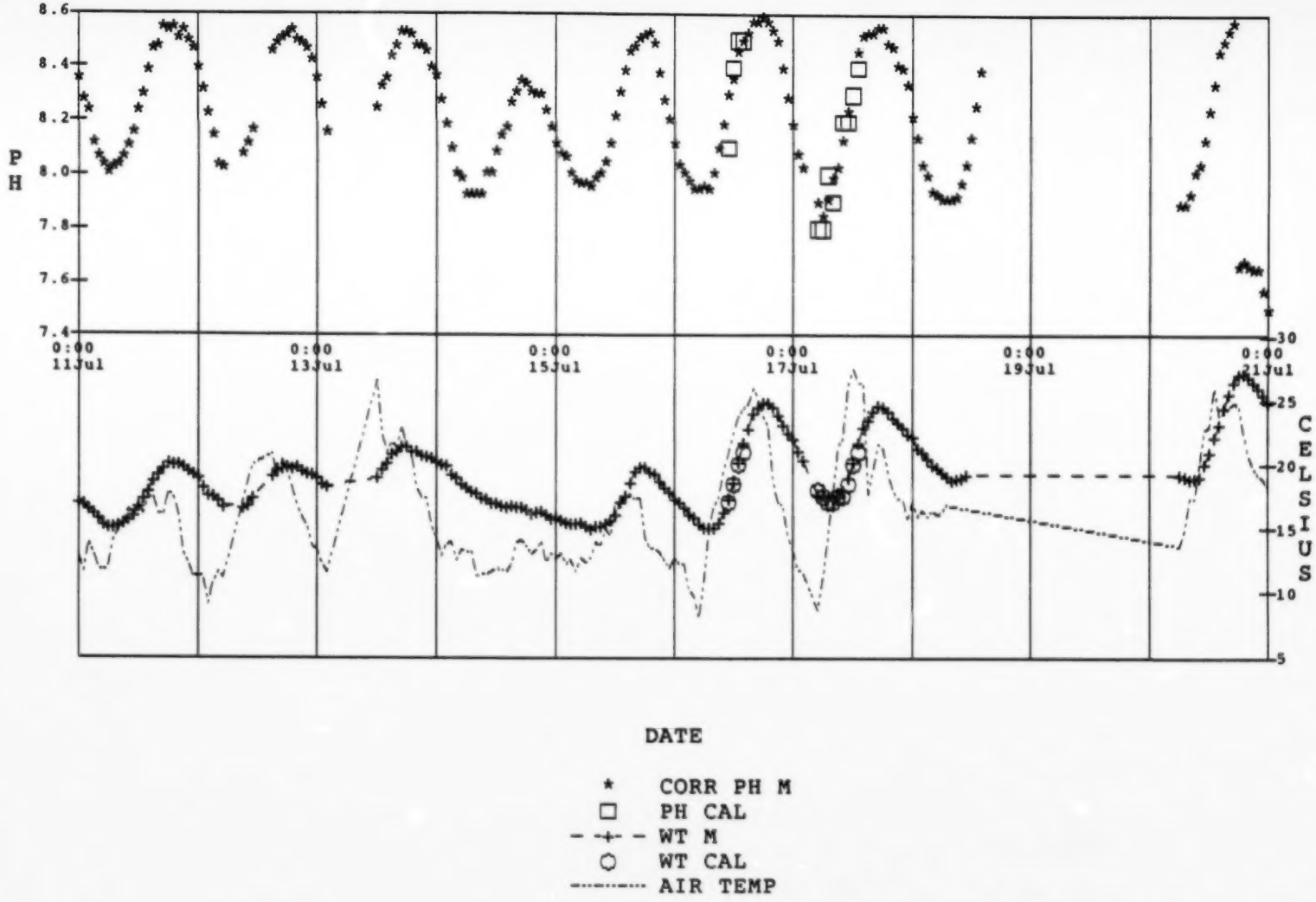


FIG. 31 PH, WATER TEMPERATURE AND AIR TEMPERATURE IN THE BIG PRESQUE ISLE STREAM DURING JULY 21-31 1986

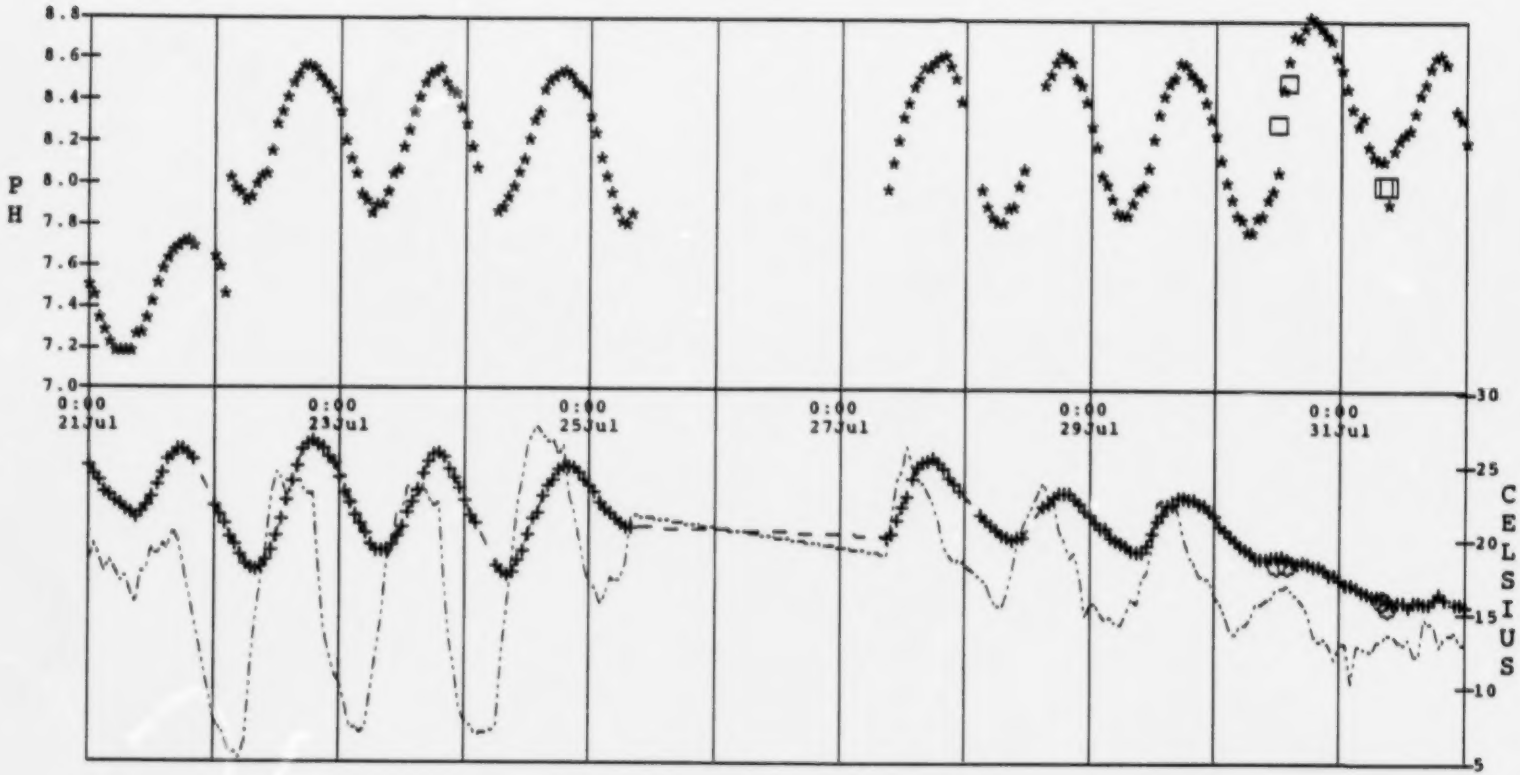


FIG. 32 PH, WATER TEMPERATURE AND AIR TEMPERATURE IN THE BIG PRESQUE ISLE STREAM DURING AUGUST 1-10 1986

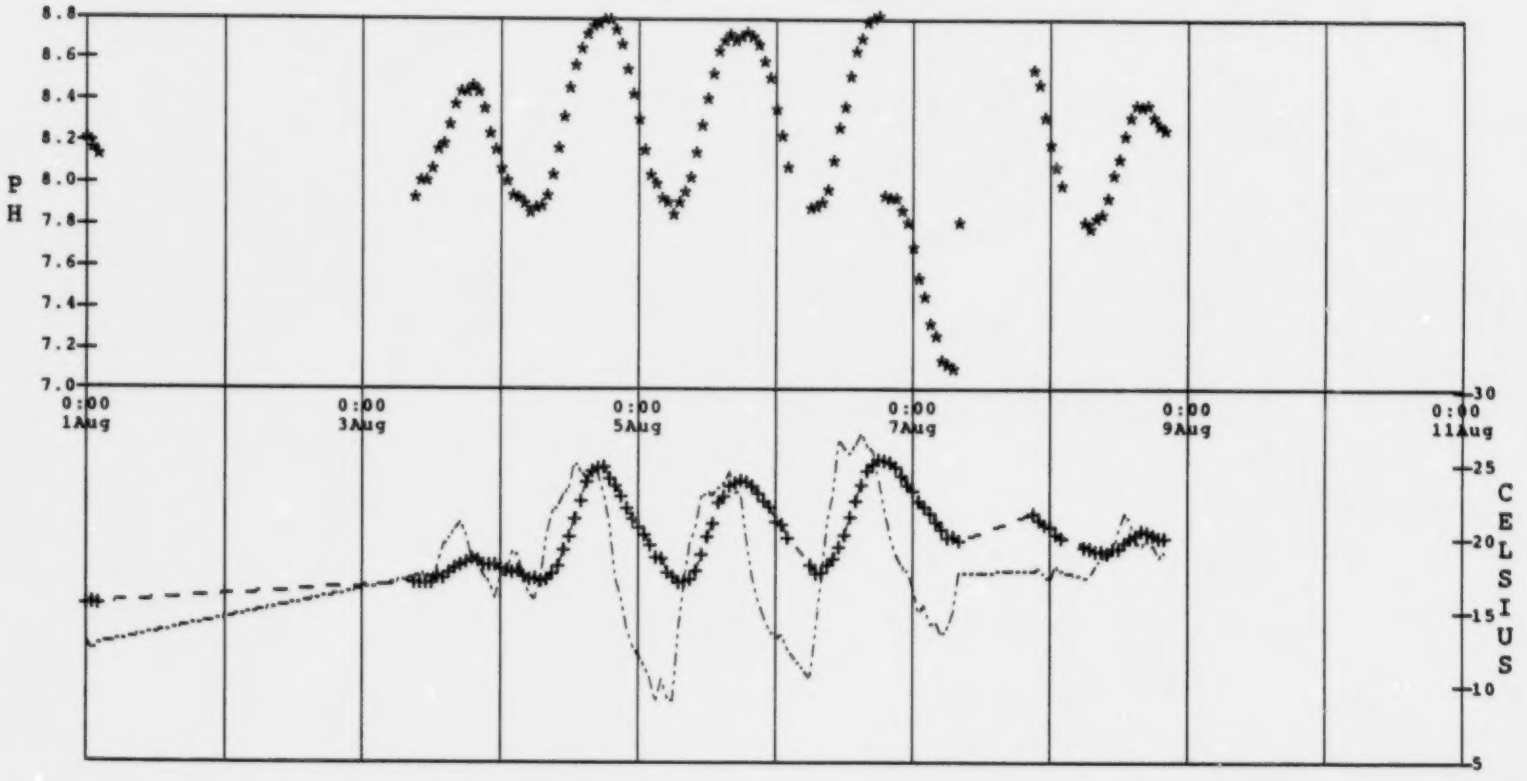


FIG. 33 PH, WATER TEMPERATURE AND AIR TEMPERATURE IN THE BIG PRESQUE ISLE STREAM DURING AUGUST 11-20 1986

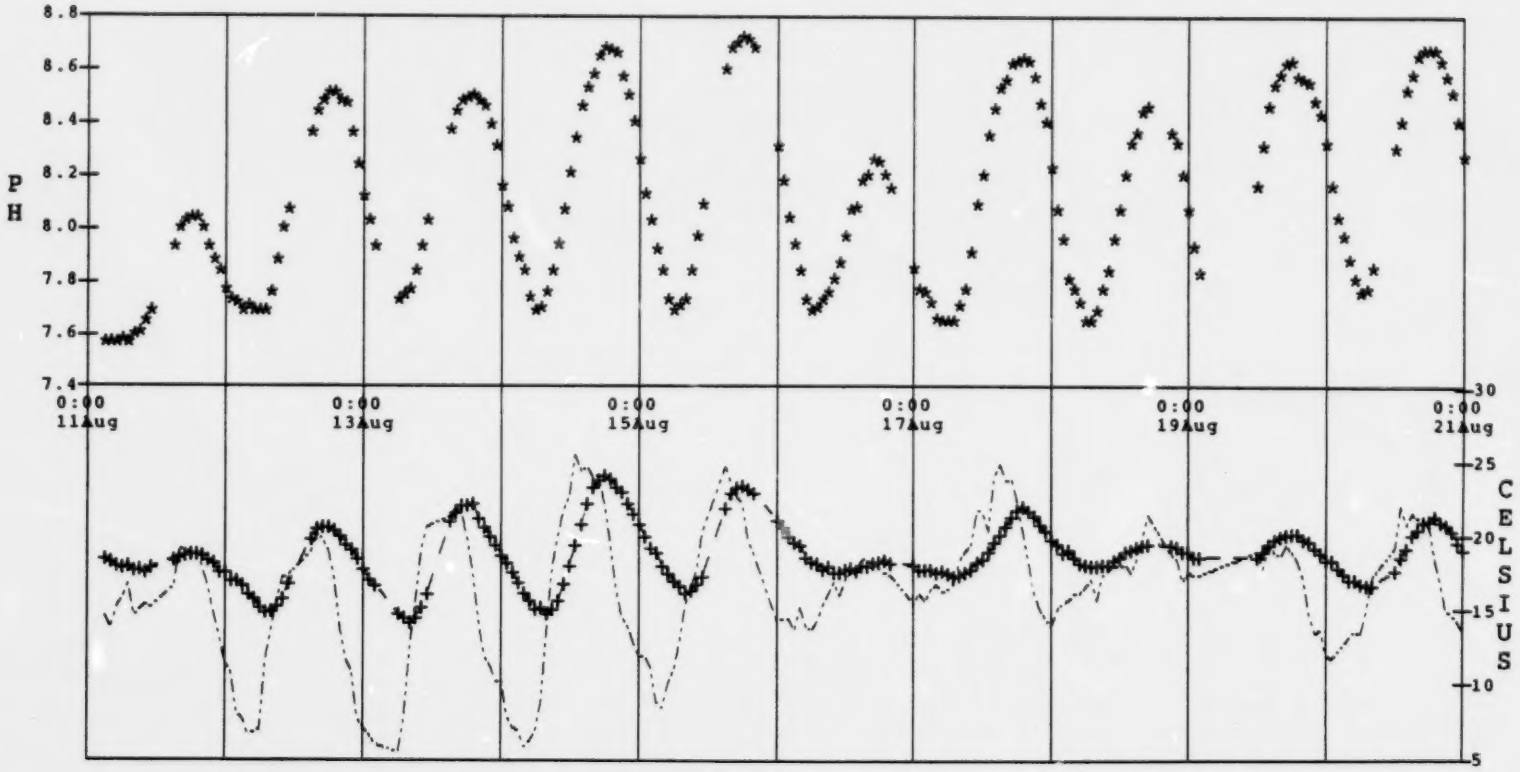


FIG. 34 PH, WATER TEMPERATURE AND AIR TEMPERATURE IN THE BIG PRESQUE ISLE STREAM DURING AUGUST 21-31 1986

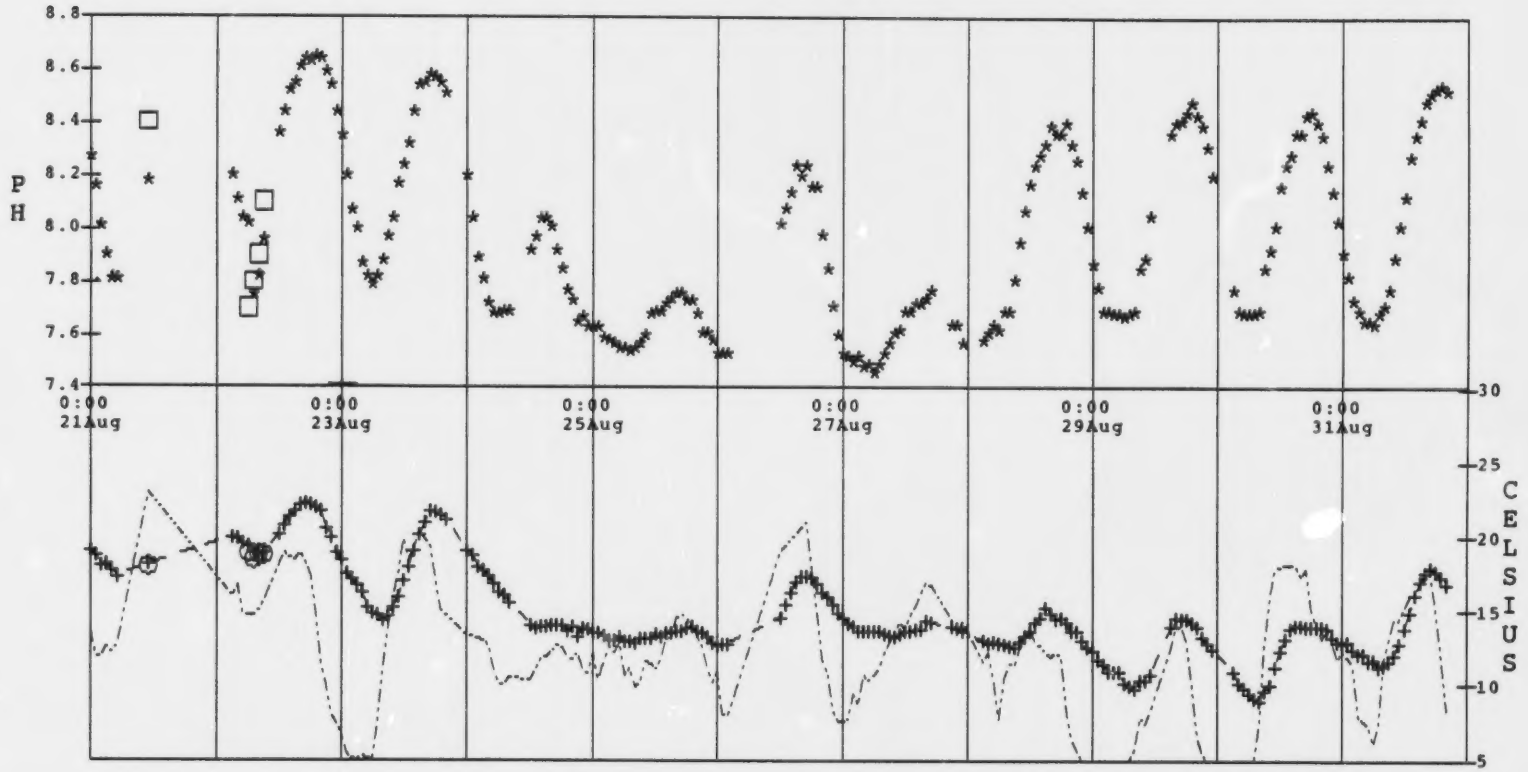


FIG. 35 PH, WATER TEMPERATURE AND AIR TEMPERATURE IN THE BIG PRESQUE ISLE STREAM DURING SEPTEMBER 1-11 1986

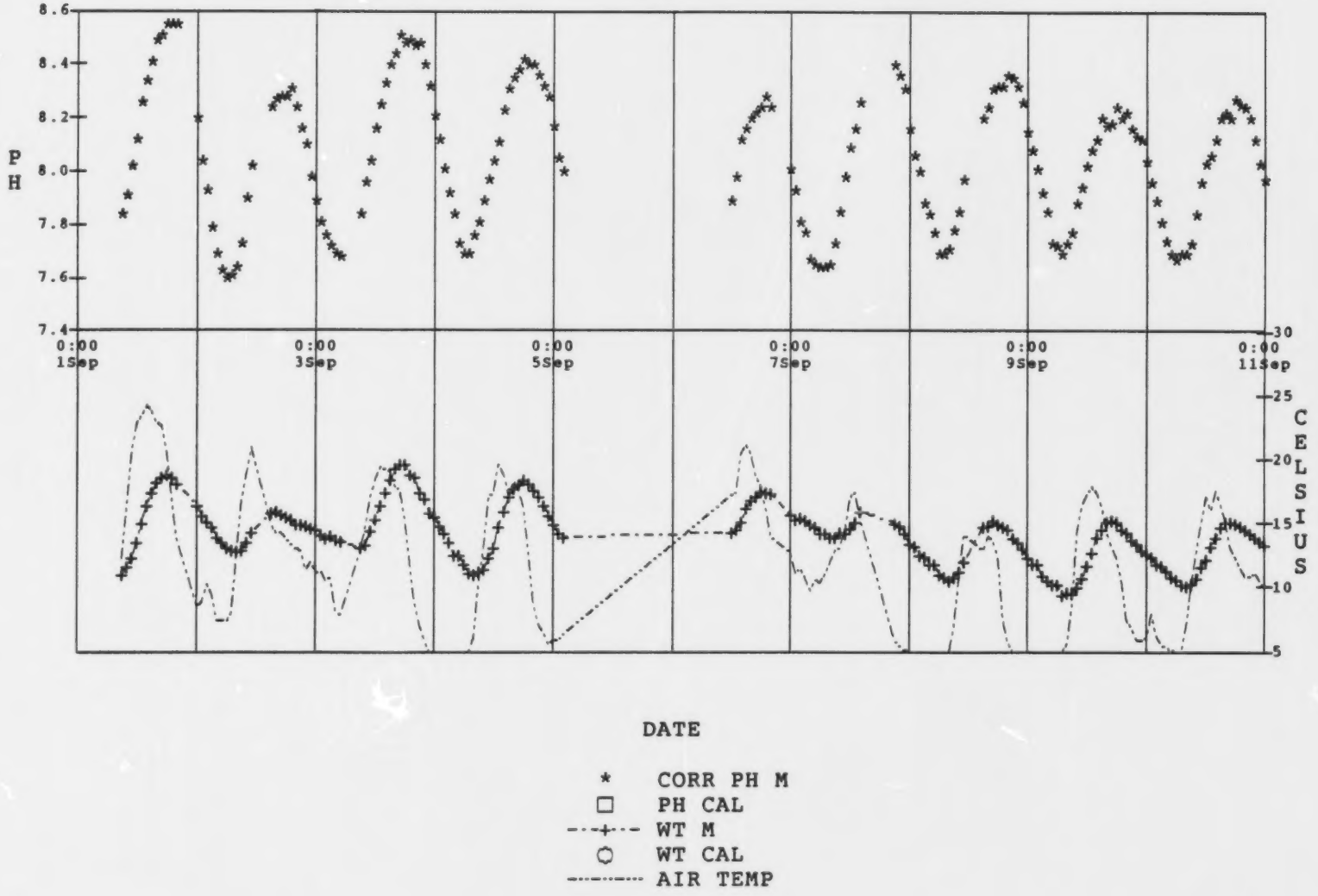


FIG. 36 PH IN THE MERSEY RIVER DURING OCTOBER 1986

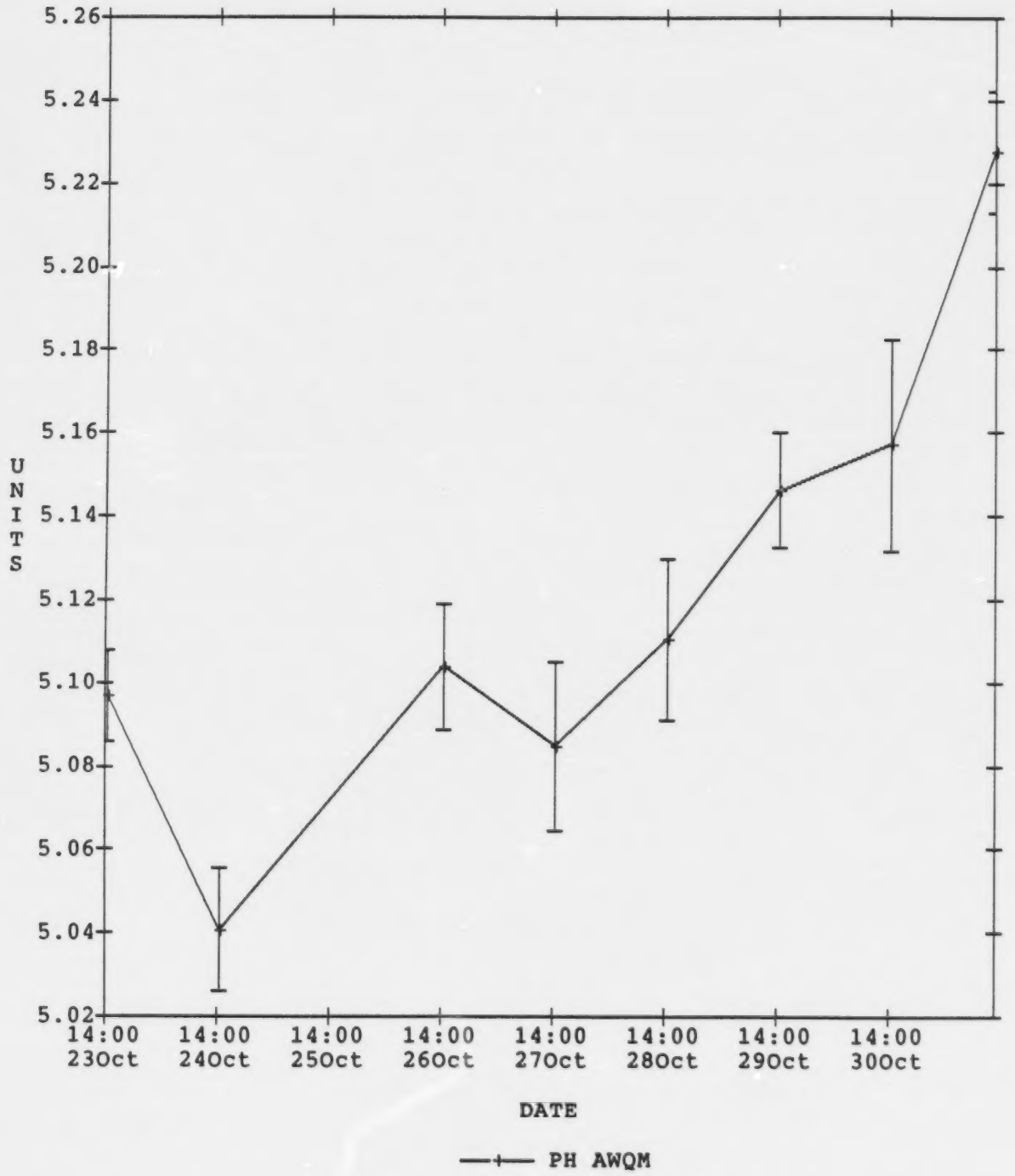


FIG. 37 PH IN THE MERSEY RIVER DURING NOVEMBER 1986

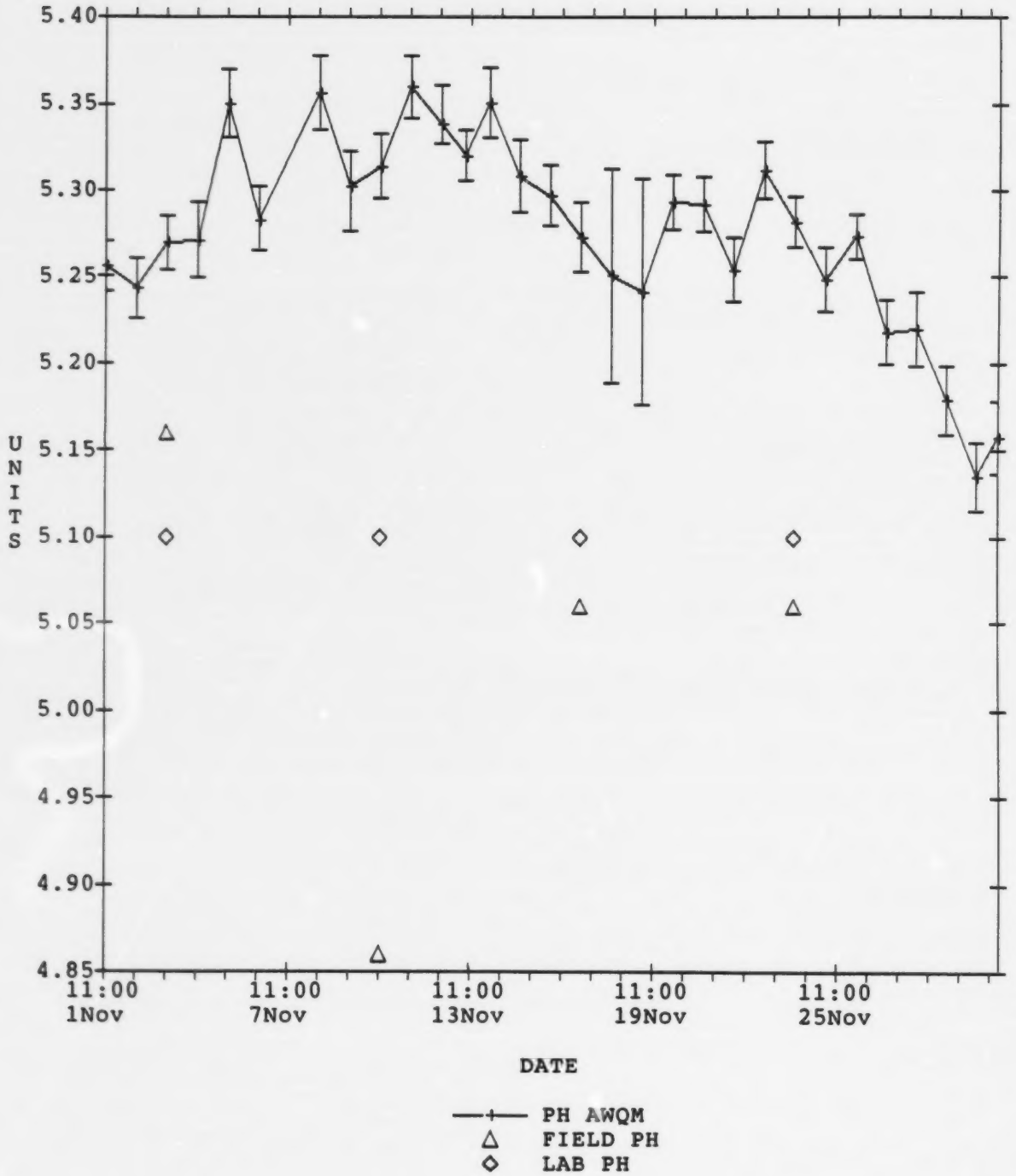


FIG. 38 PH IN THE MERSEY RIVER DURING DECEMBER 1986

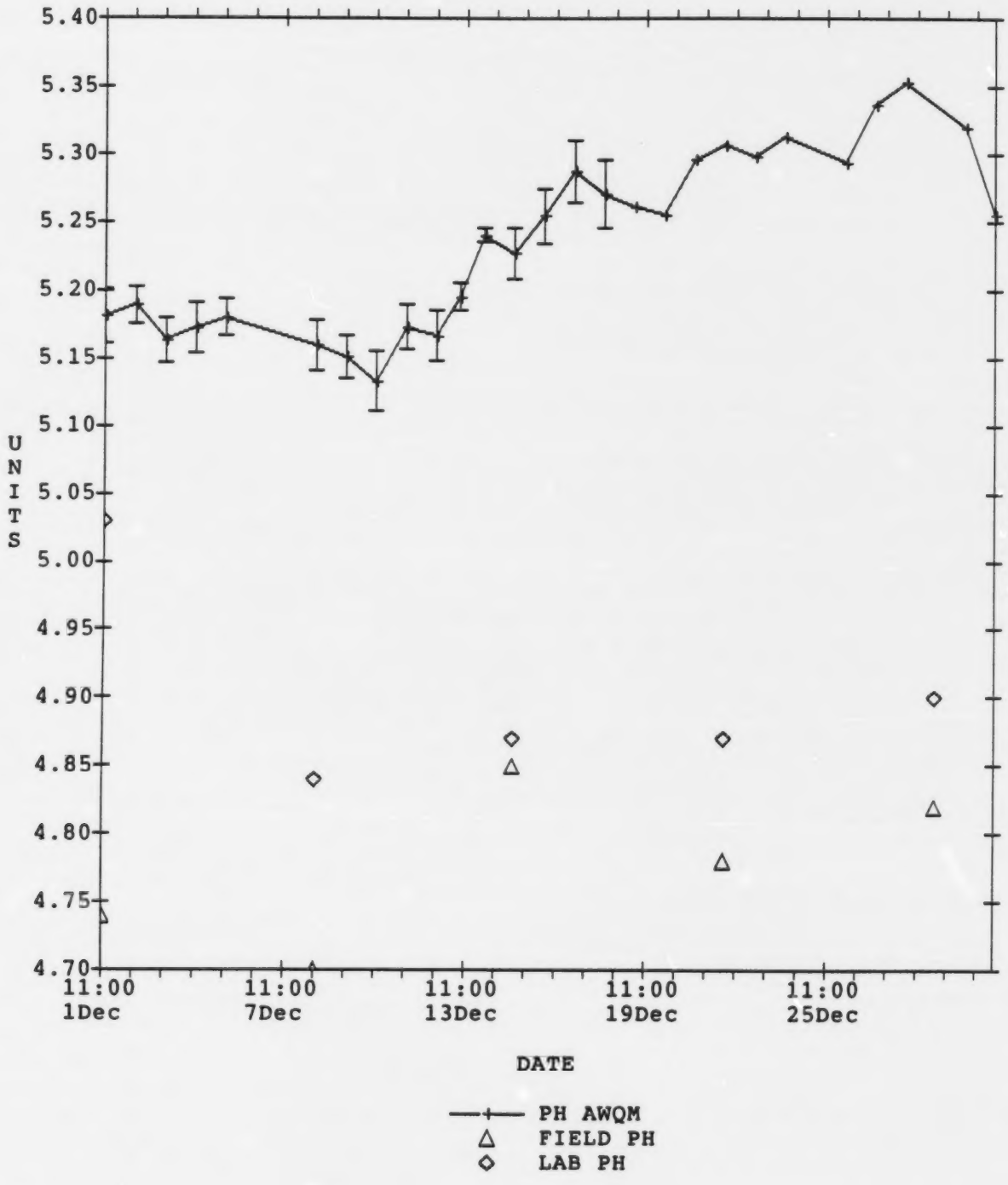


FIG. 39 PH IN THE MERSEY RIVER DURING JANUARY 1987

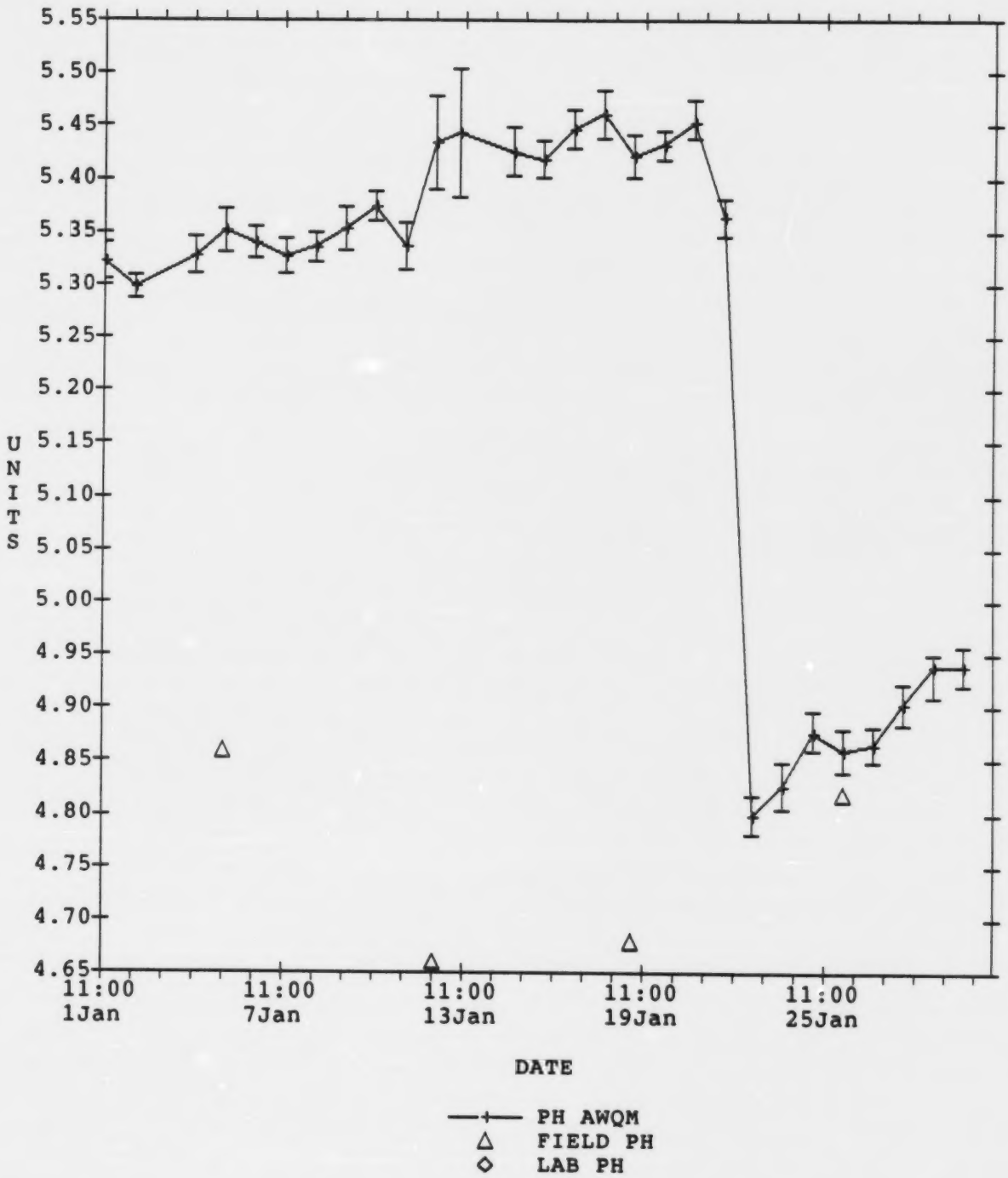


FIG. 40 PH IN THE MERSEY RIVER DURING FEBRUARY 1987

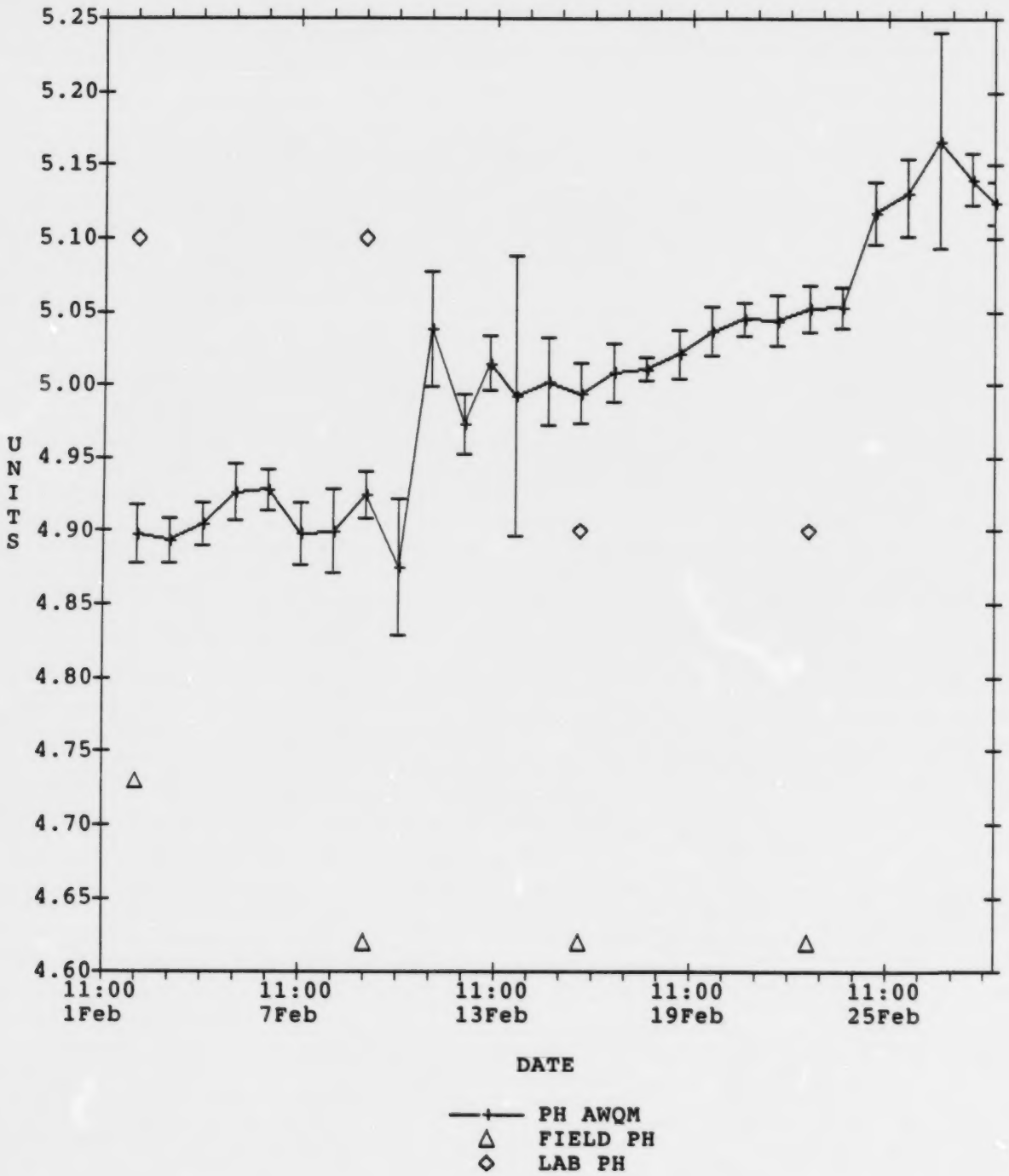
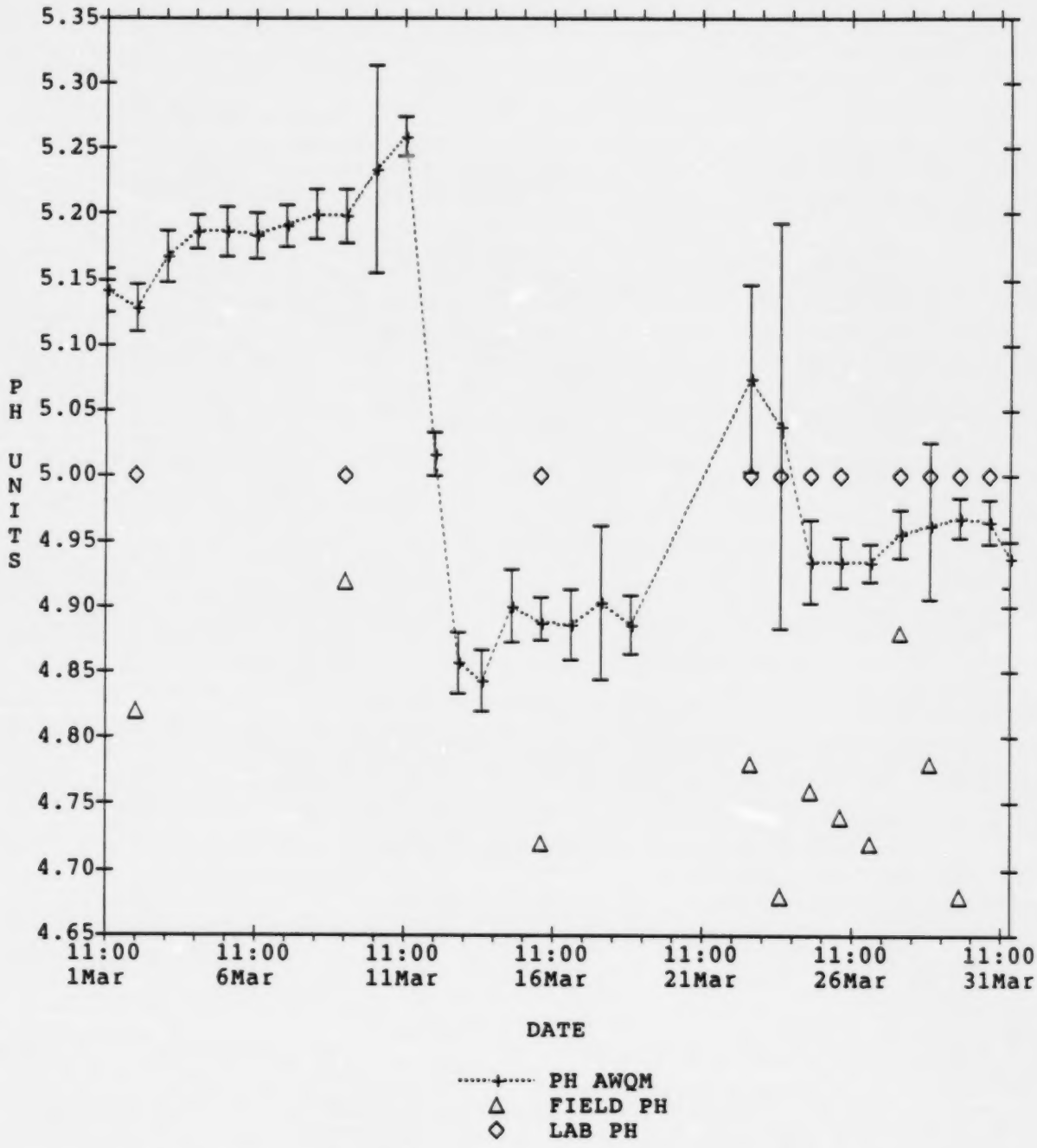
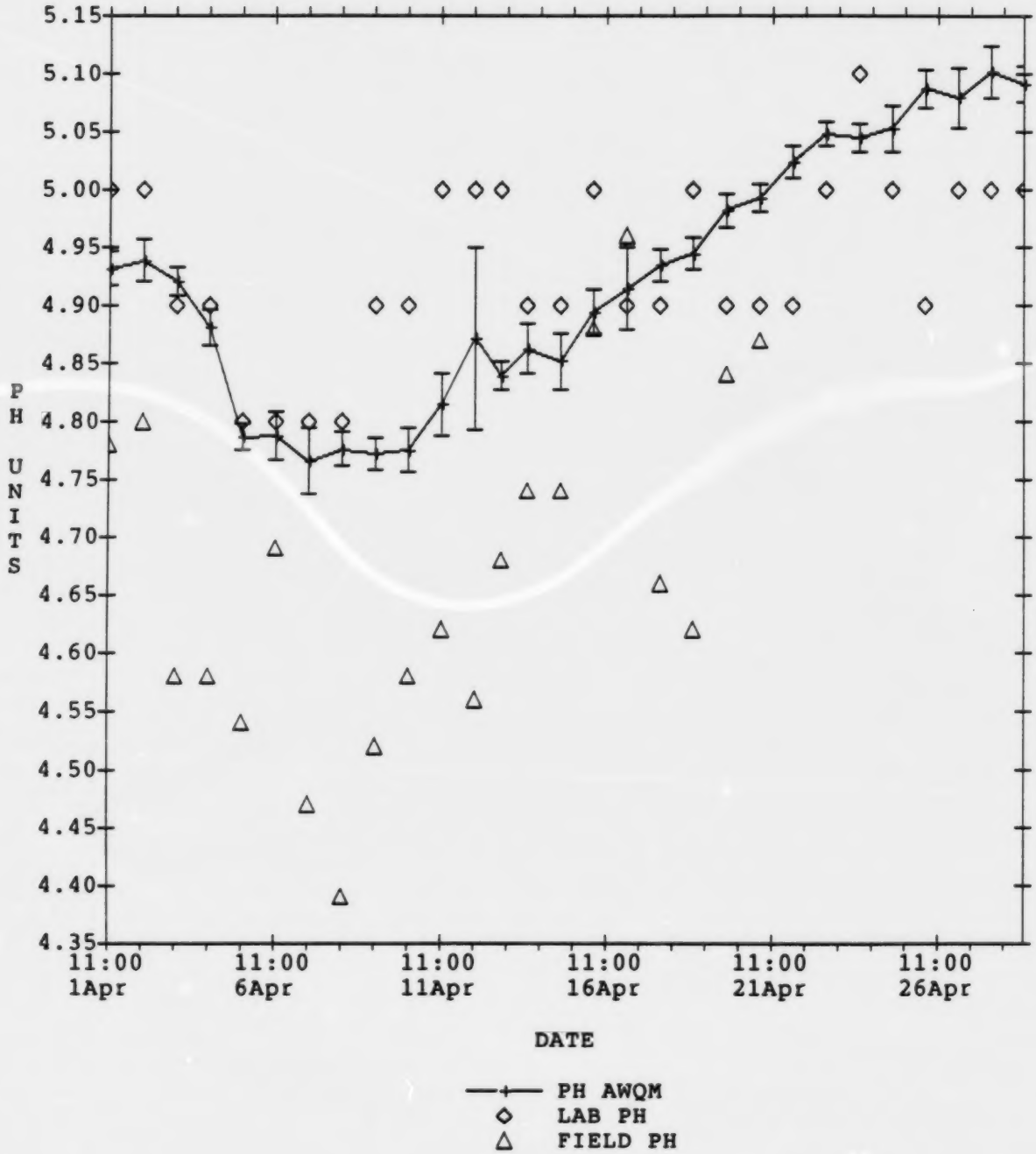


FIG. 41 PH IN THE MERSEY RIVER DURING MARCH 1987



SNOWMELT STARTED ON MARCH 22

FIG. 42 PH IN THE MERSEY RIVER DURING APRIL 1987



SNOWMELT ENDED ON APRIL 6

FIG. 43. SPECIFIC CONDUCTANCE, WATER TEMPERATURE AND AIR TEMPERATURE AT THE MERSEY RIVER DURING OCTOBER 1986

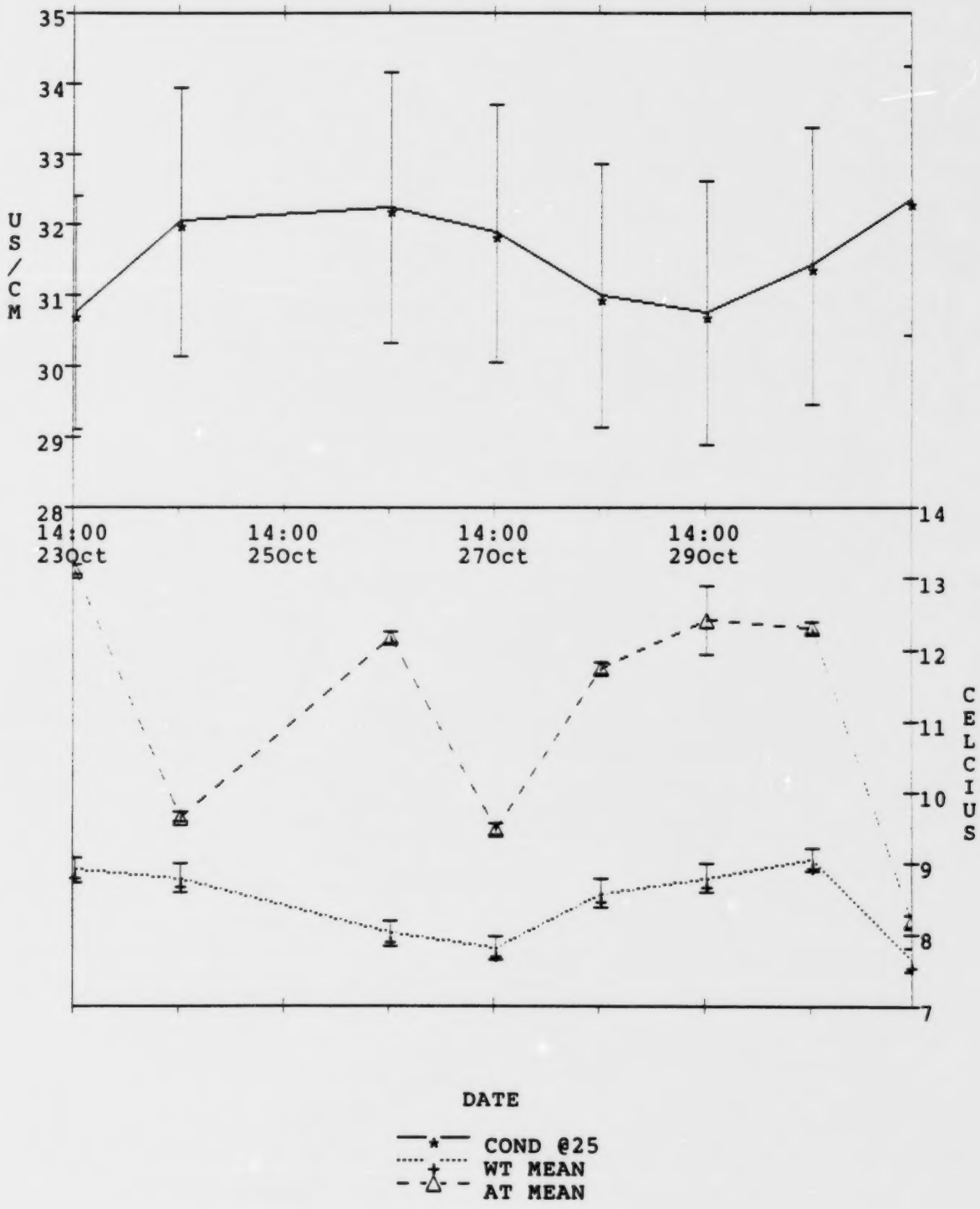


FIG. 44. SPECIFIC CONDUCTANCE, WATER TEMPERATURE AND AIR TEMPERATURE AT THE MERSEY RIVER DURING NOVEMBER 1986

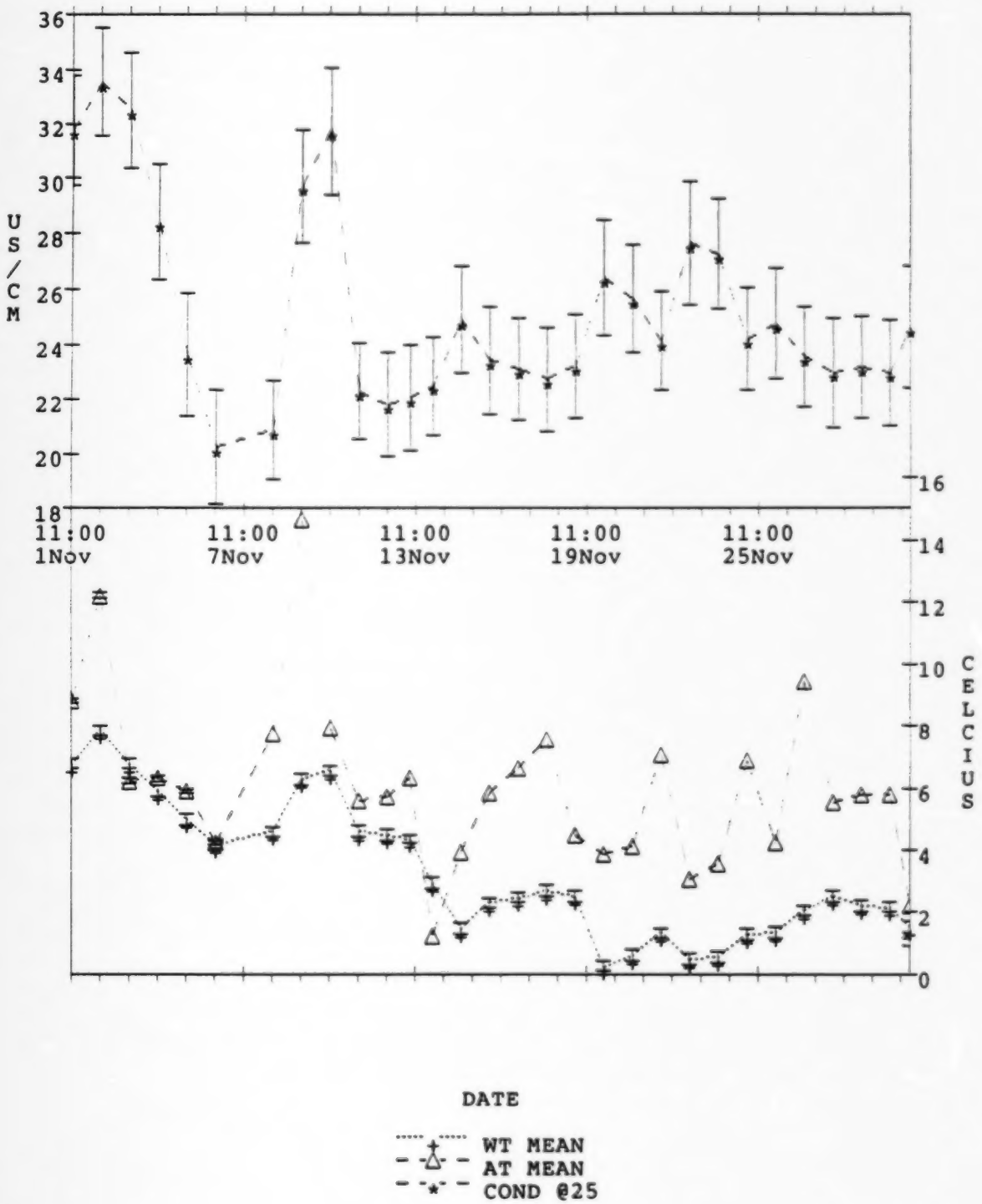


FIG. 45. SPECIFIC CONDUCTANCE, WATER TEMPERATURE AND AIR TEMPERATURE AT THE MERSEY RIVER DURING DECEMBER 1986

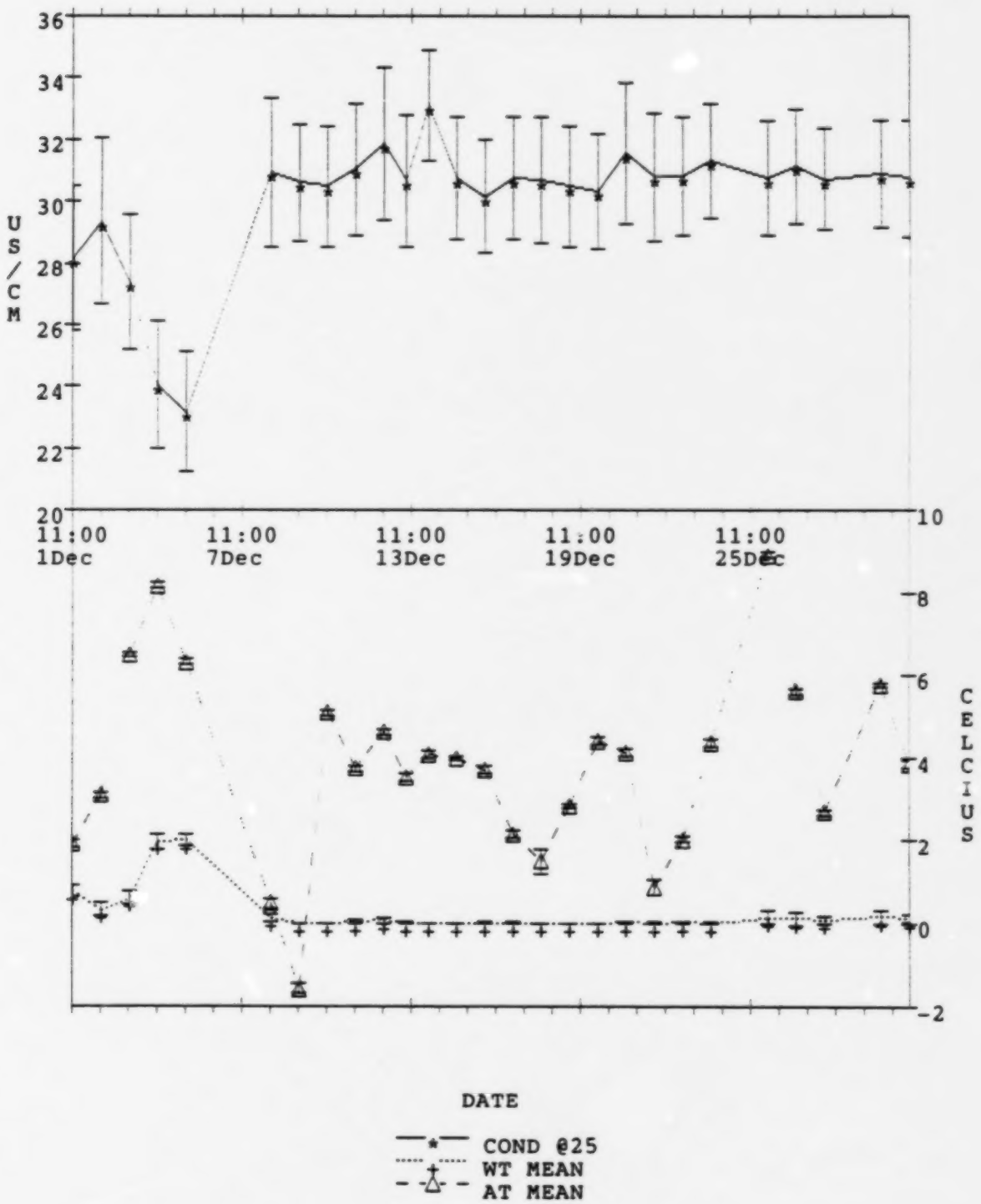


FIG. 46. SPECIFIC CONDUCTANCE, WATER TEMPERATURE AND AIR TEMPERATURE AT THE MERSEY RIVER DURING JANUARY 1987

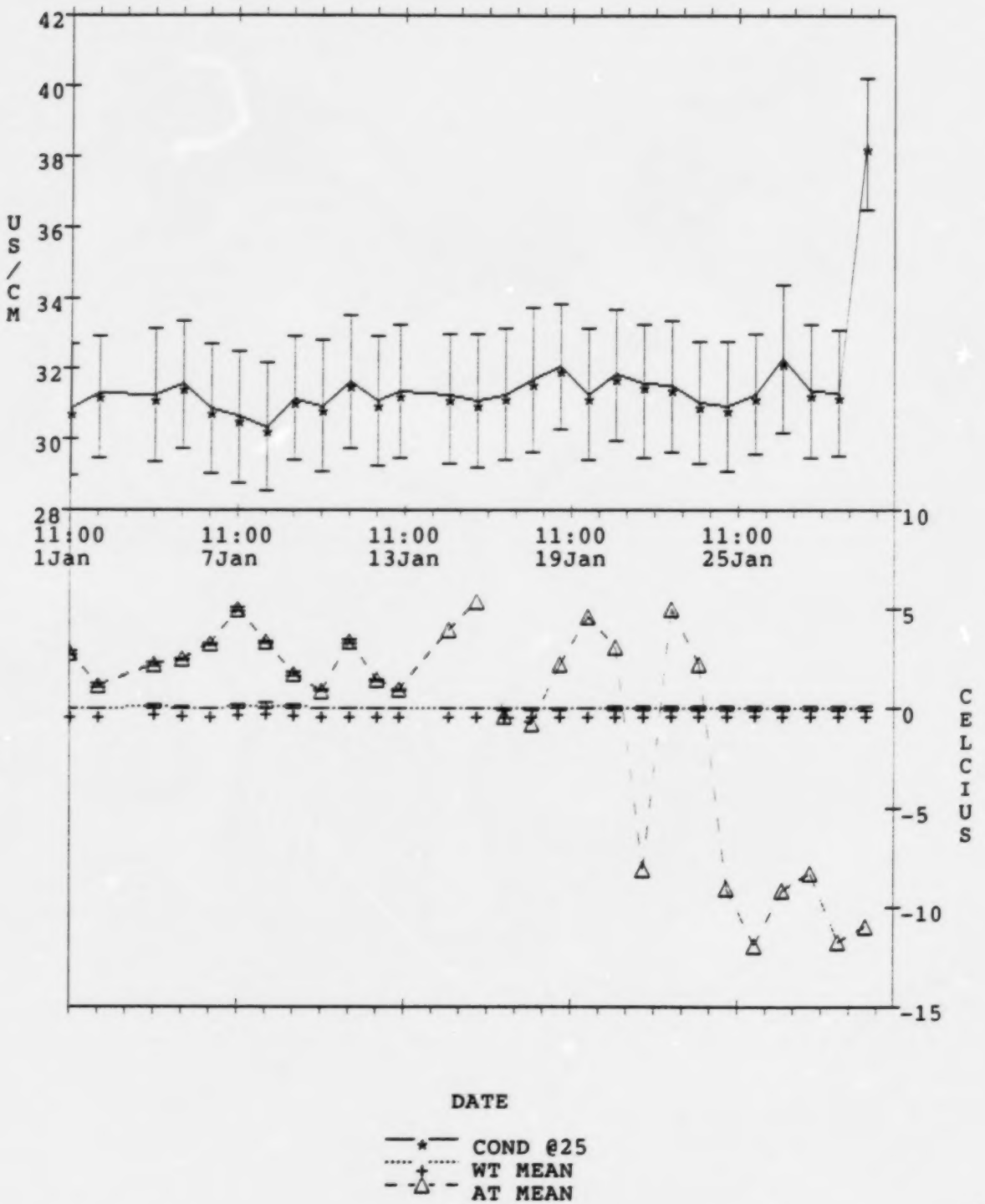


FIG. 47. SPECIFIC CONDUCTANCE, WATER TEMPERATURE AND AIR TEMPERATURE AT THE MERSEY RIVER DURING FEBRUARY 1987

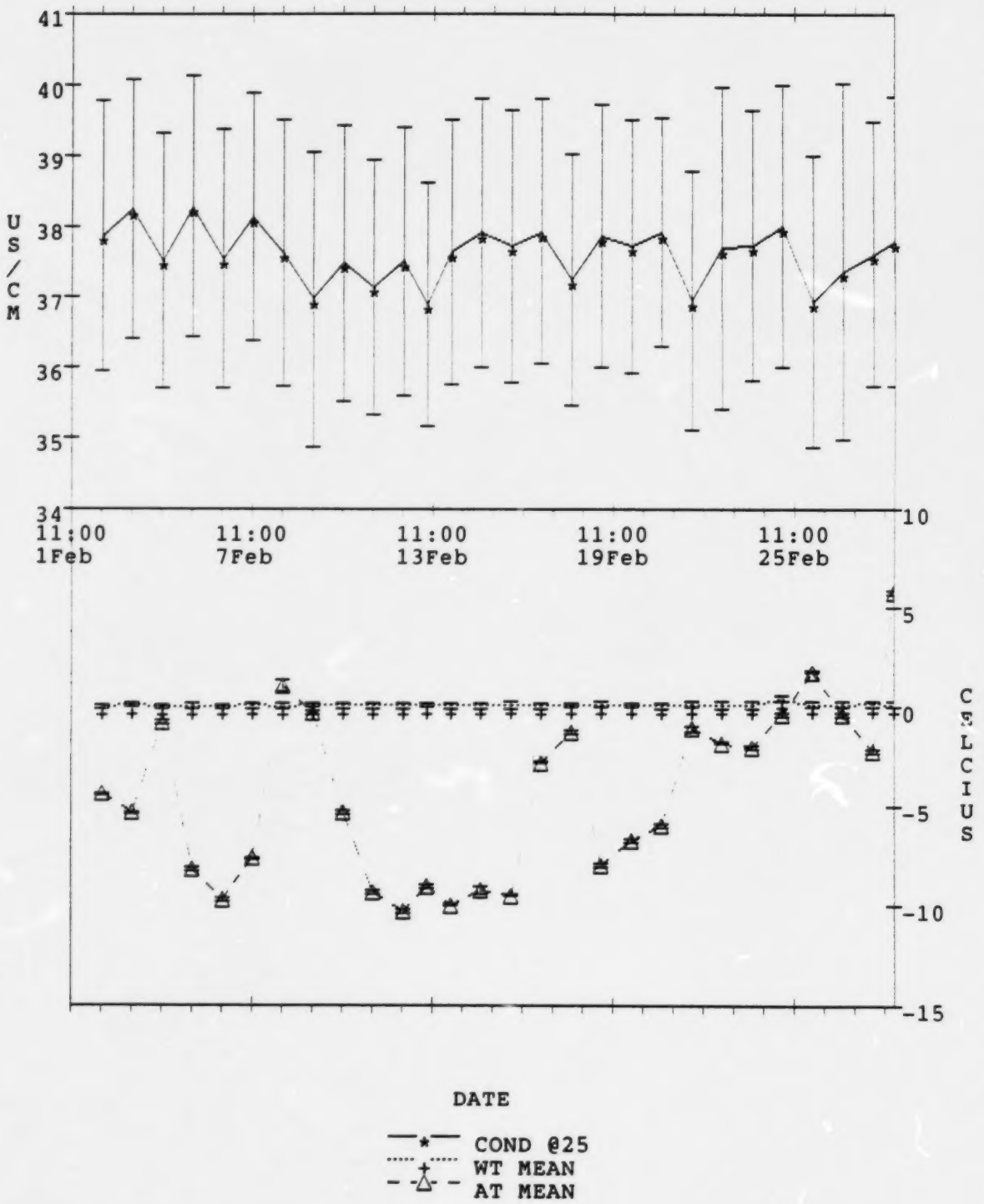


FIG. 48. SPECIFIC CONDUCTANCE, WATER TEMPERATURE AND AIR TEMPERATURE AT THE MERSEY RIVER DURING MARCH 1987

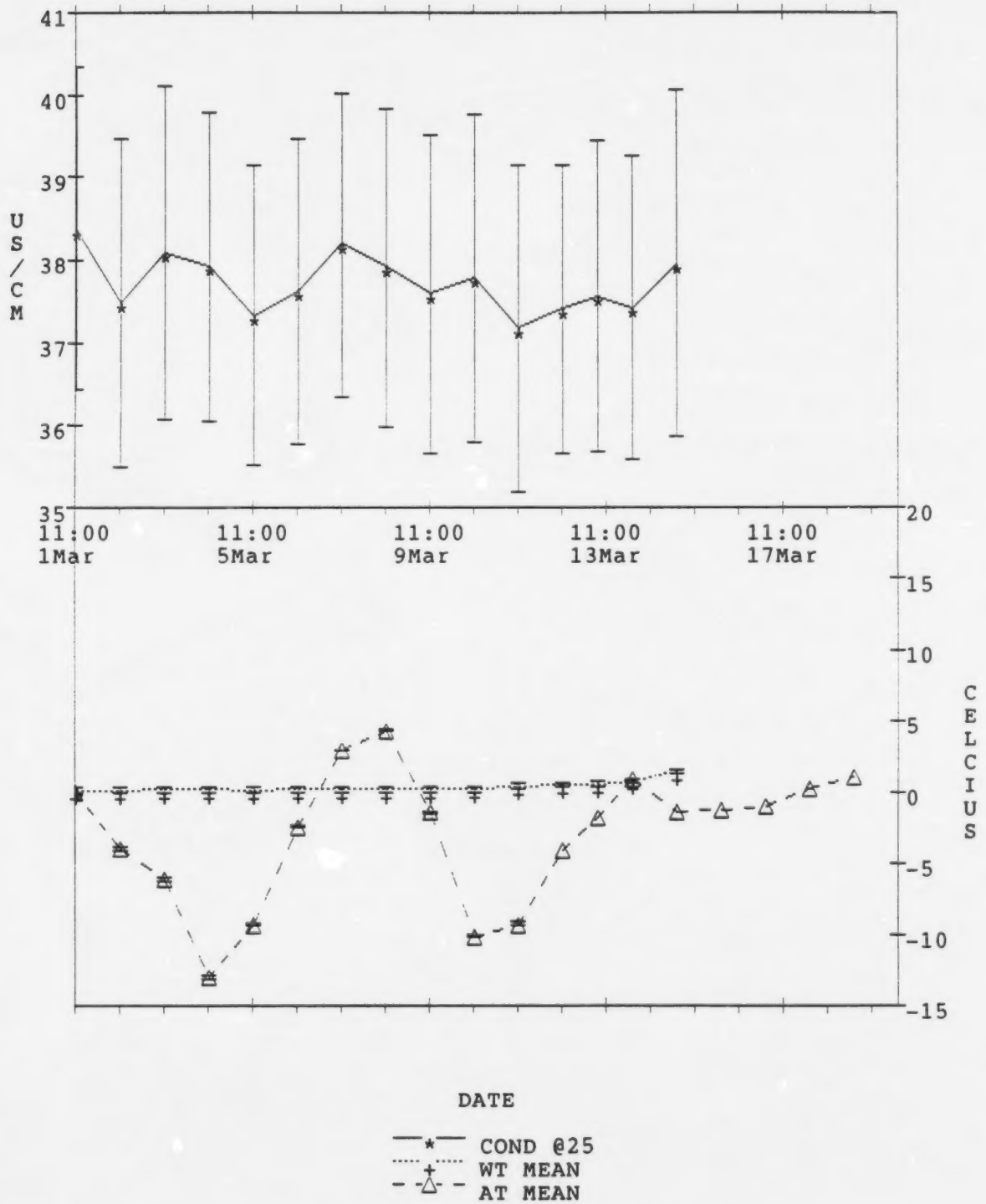


FIG. 49 DAILY MEAN DISCHARGE IN THE MERSEY RIVER DURING OCTOBER 1986

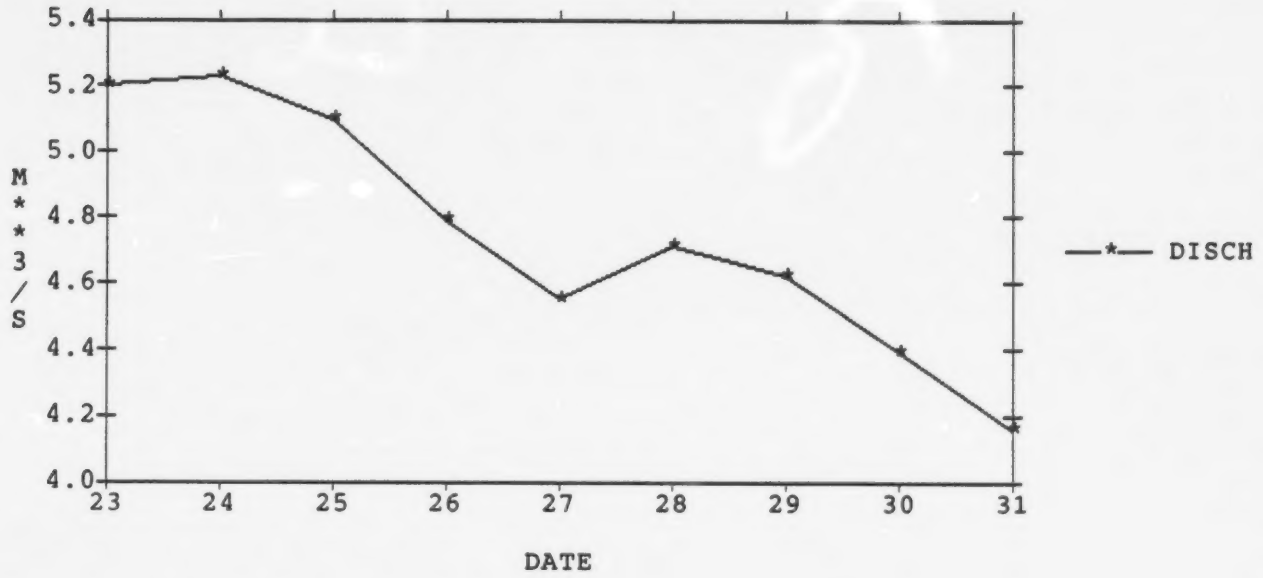


FIG. 50 DAILY MEAN DISCHARGE IN THE MERSEY RIVER DURING NOVEMBER 1986

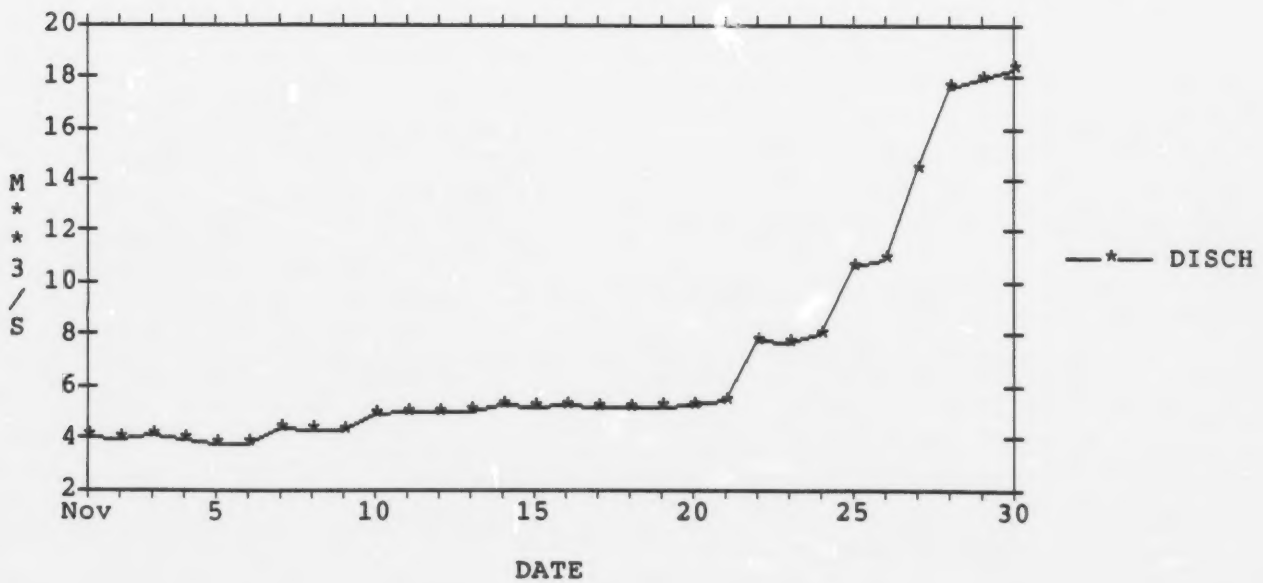


FIG. 51a. DAILY MEAN DISCHARGE IN THE MERSEY RIVER DURING DECEMBER 1986

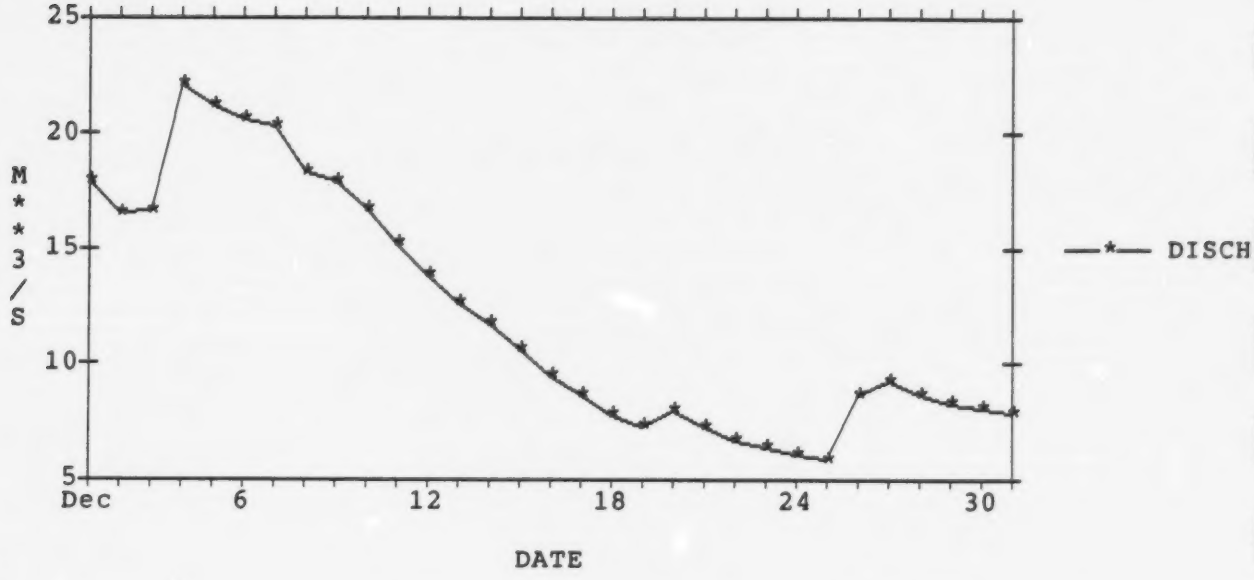


FIG. 51b. SNOW PACK HEIGHT IN THE MERSEY RIVER BASIN DURING DECEMBER 1986

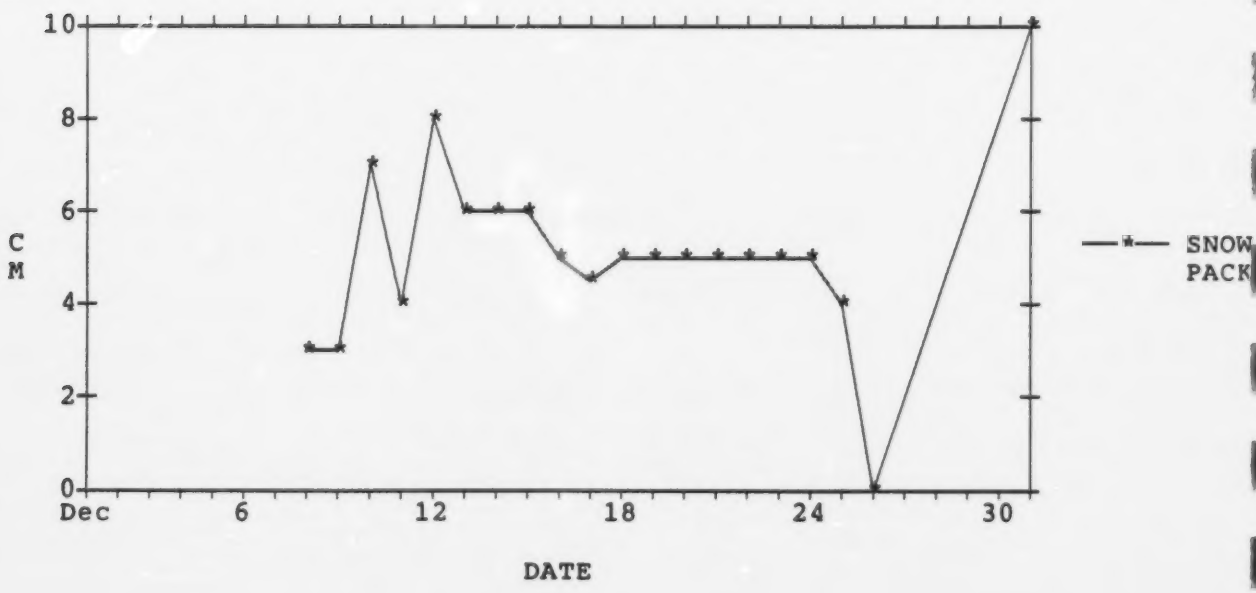


FIG. 52a. DAILY MEAN DISCHARGE IN THE MERSEY RIVER DURING JANUARY 1987

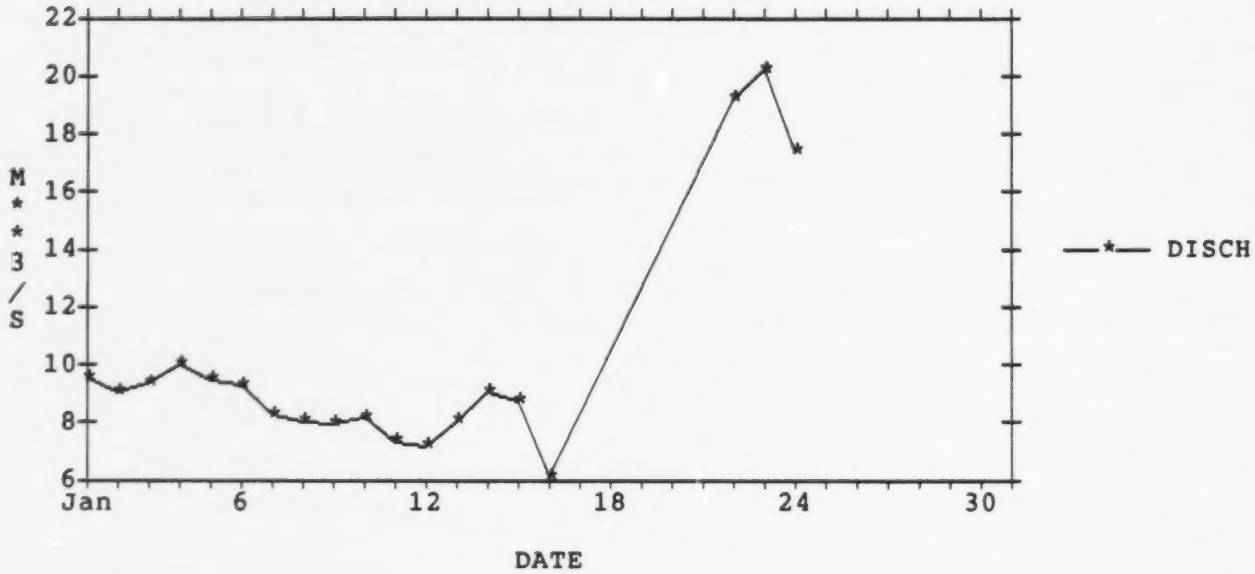


FIG. 52b. SNOW PACK HEIGHT AND WATER CONTENT IN THE MERSEY RIVER BASIN DURING JANUARY 1987

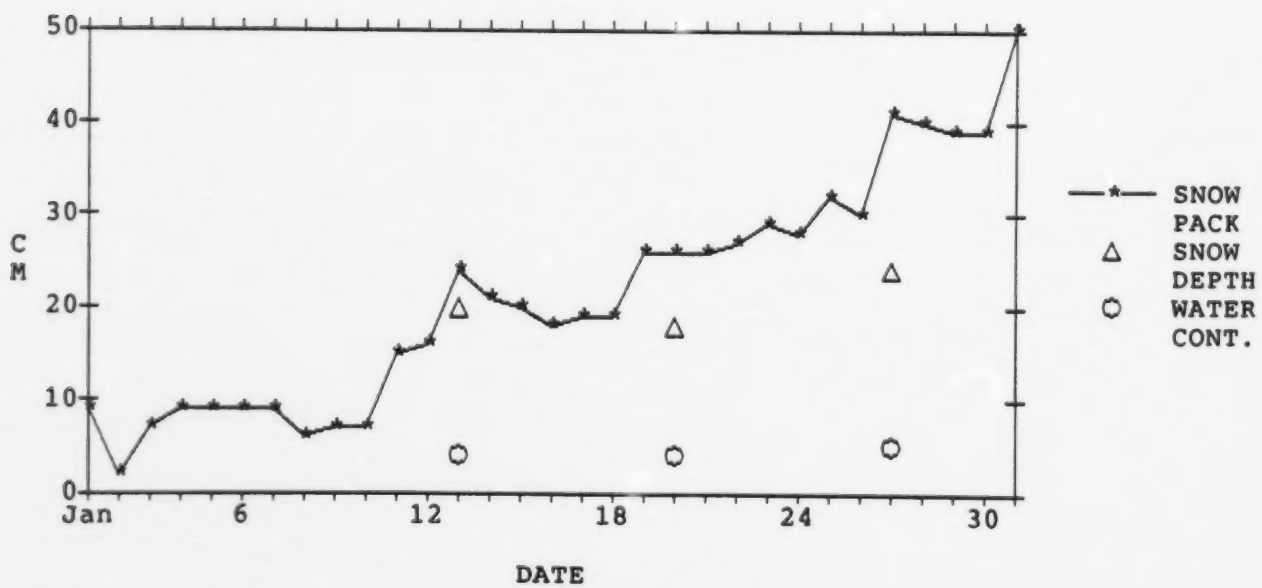


FIG. 53 SNOWPACK HEIGHT AND WATER CONTENT IN THE MERSEY RIVER BASIN DURING FEBRUARY 1987

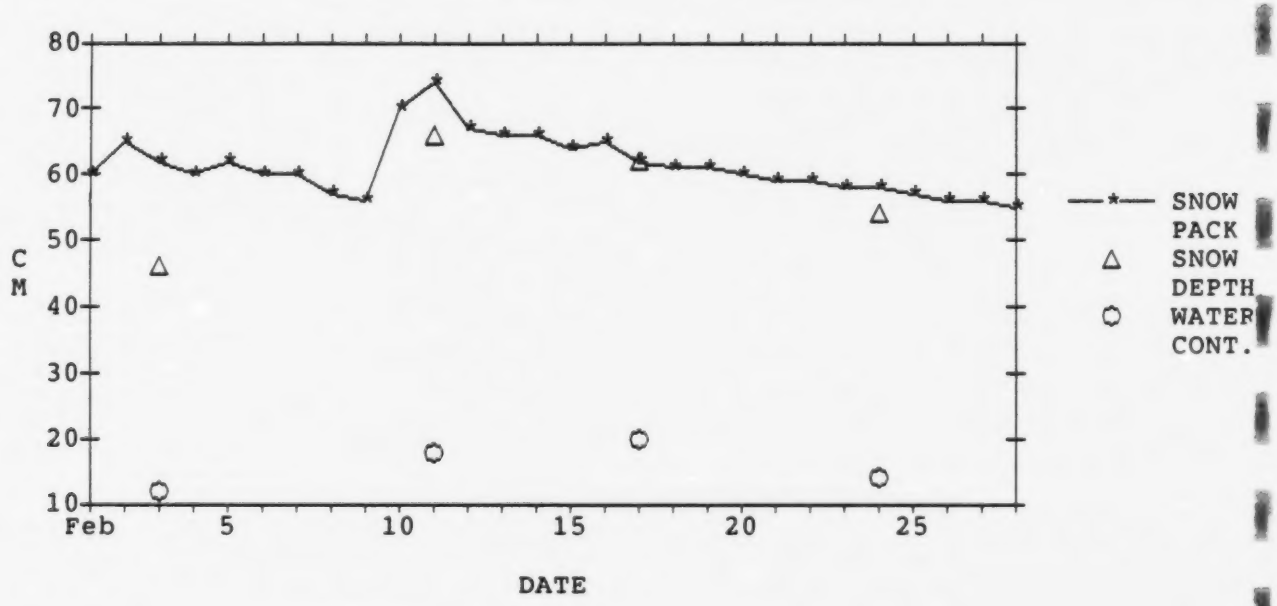


FIG. 54a. DAILY MEAN DISCHARGE IN THE MERSEY RIVER DURING MARCH 1987

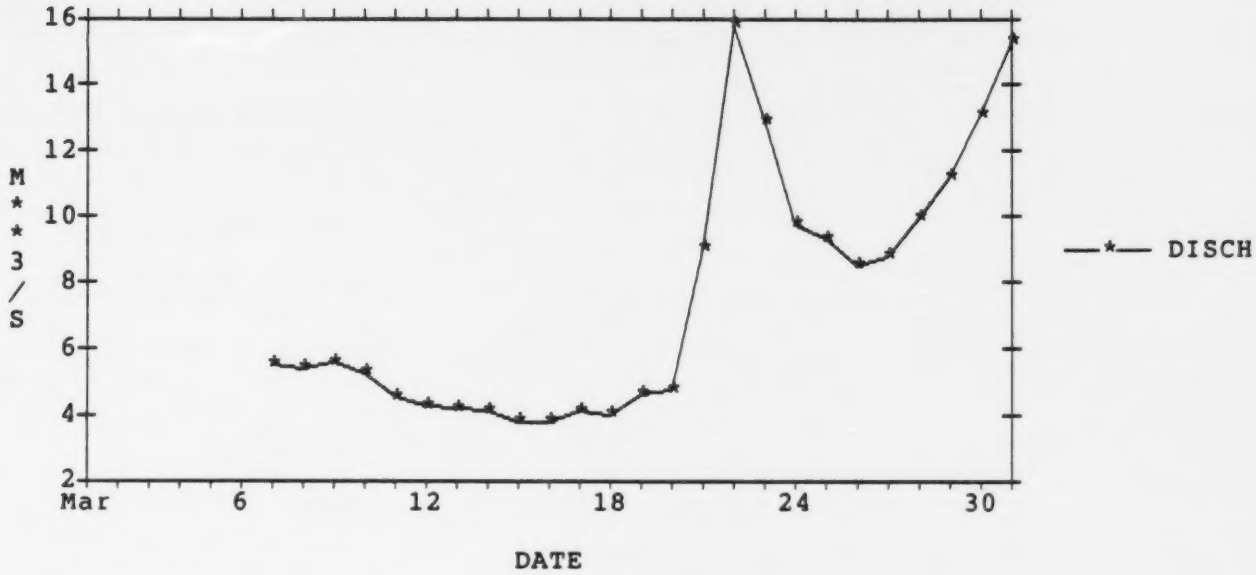


FIG. 54b. SNOWPACK HEIGHT AND WATER CONTENT IN THE MERSEY RIVER BASIN DURING MARCH 1987

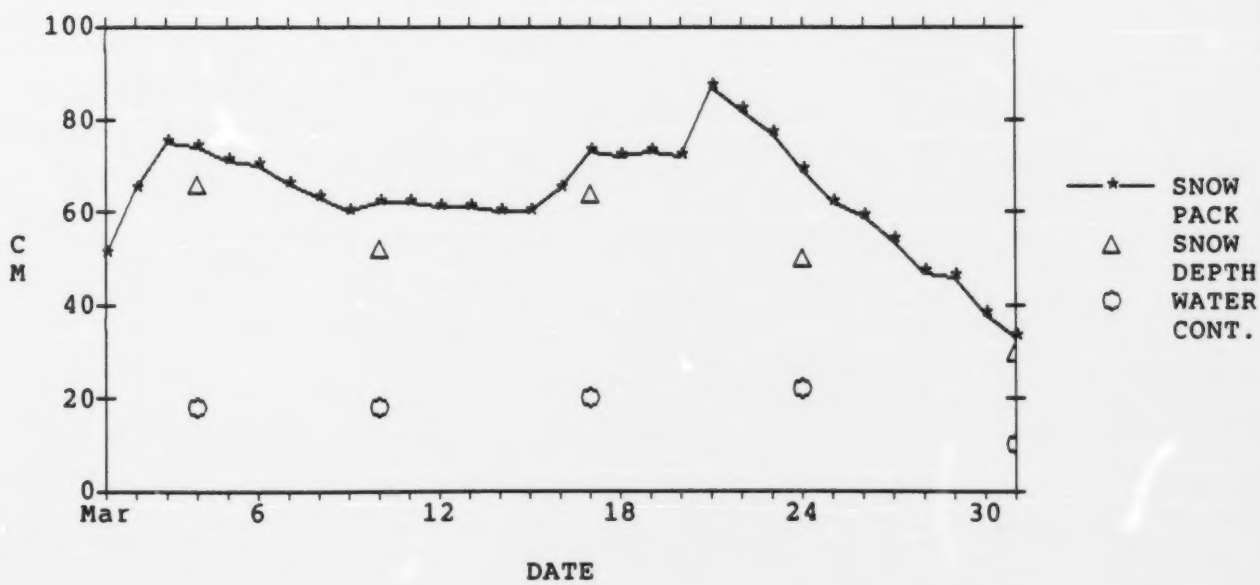


FIG. 55a DAILY MEAN DISCHARGE IN THE MERSEY RIVER DURING APRIL 1987

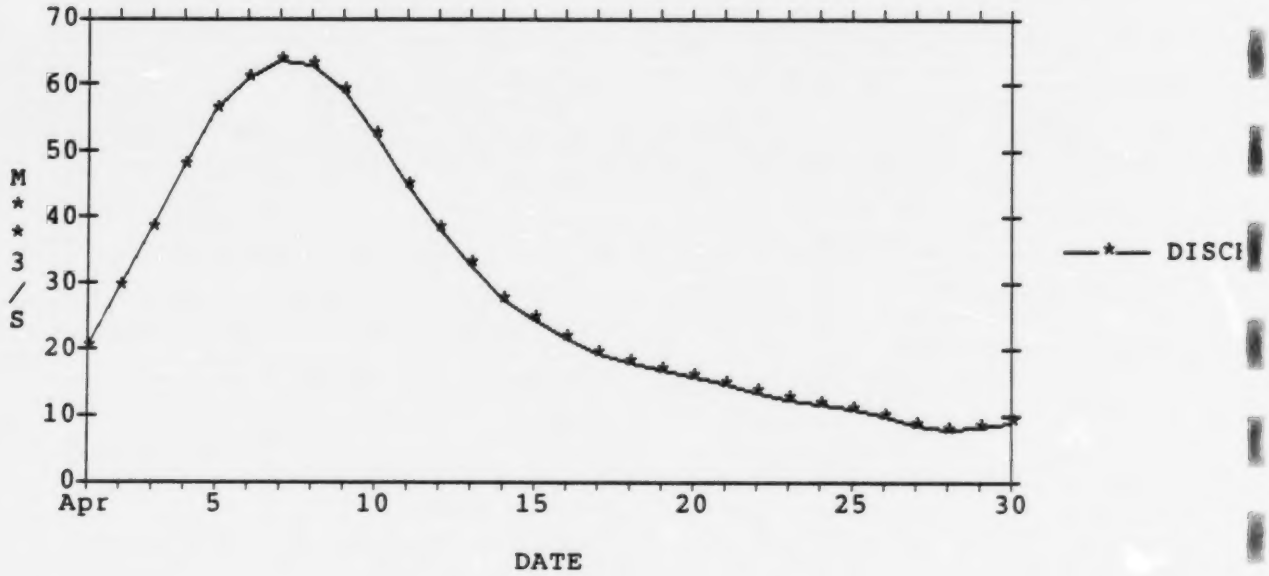


FIG. 55b SNOW PACK HEIGHT IN THE MERSEY RIVER BASIN DURING APRIL 1987

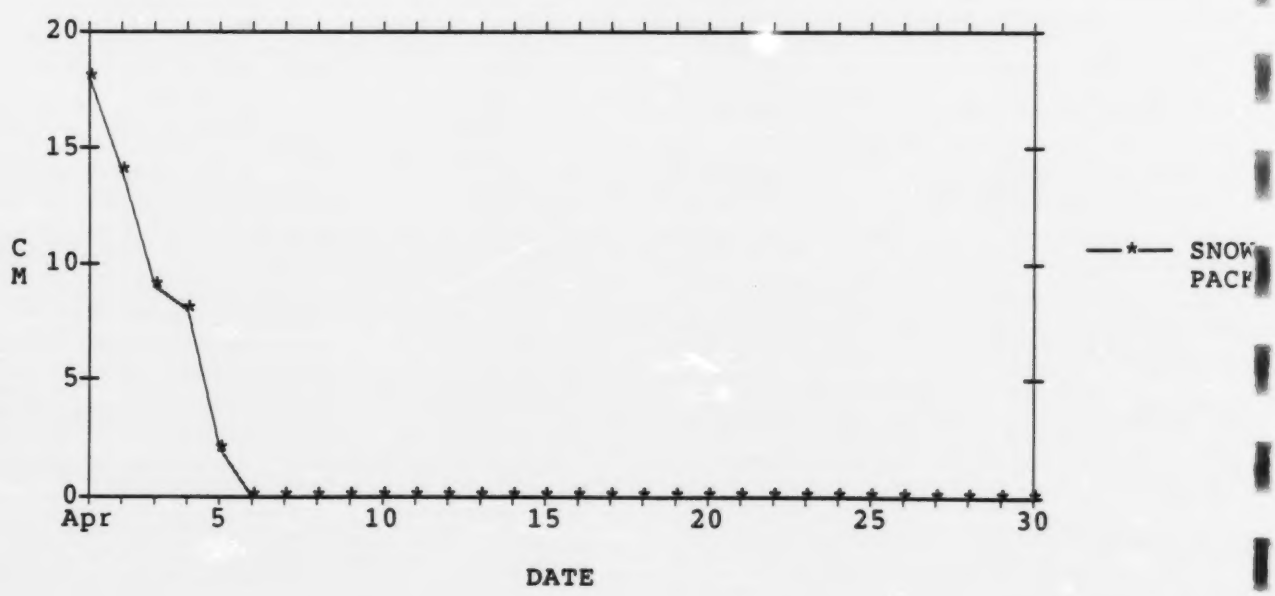


FIG. 56 PRECIPITATION DEPTH AND MAX-MIN TEMPERATURES AT THE MERSEY RIVER AREA DURING MARCH 1987

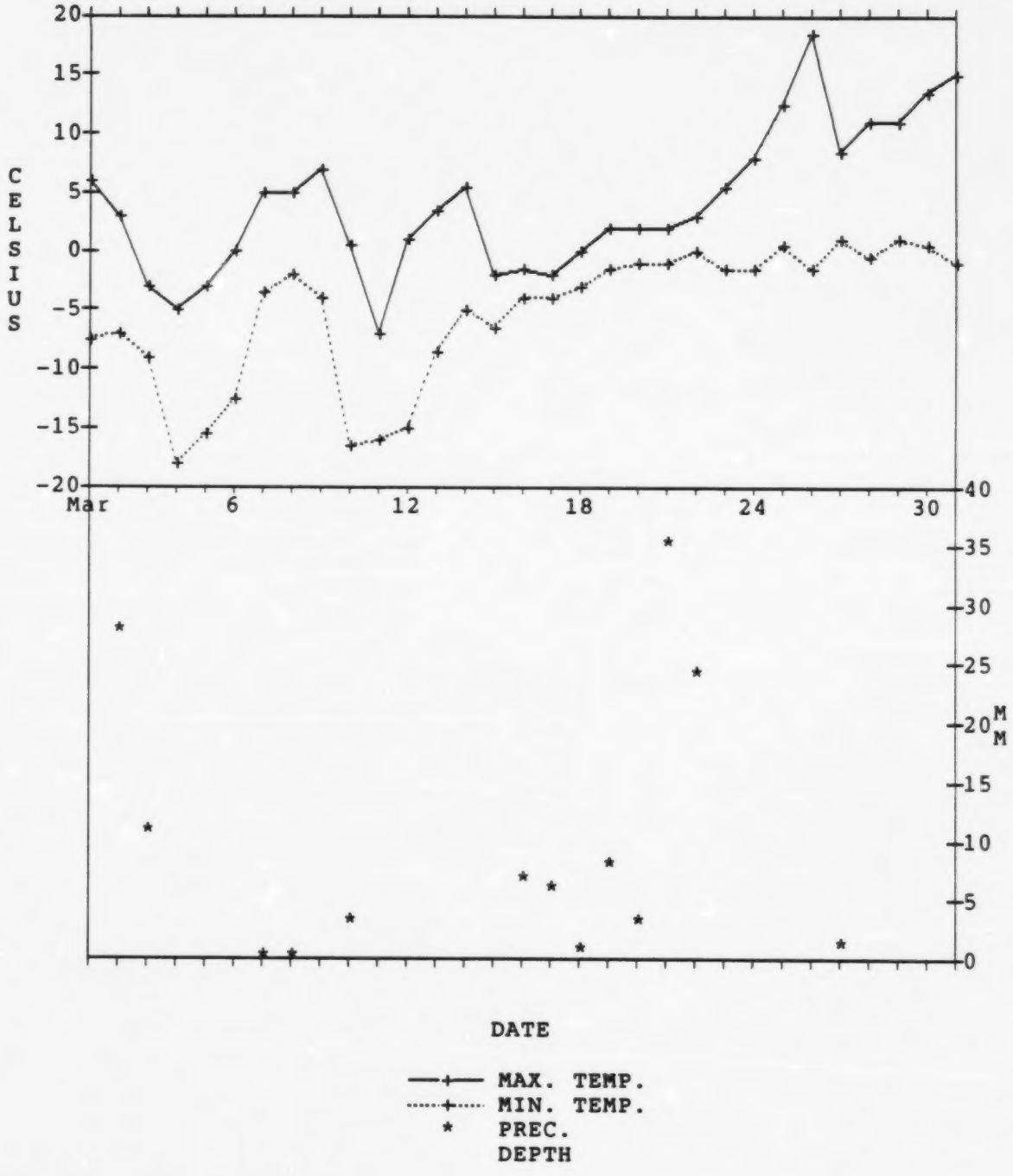


FIG. 57 PRECIPITATION DEPTH AND MAX-MIN TEMPERATURES AT THE MERSEY RIVER AREA DURING APRIL 1987

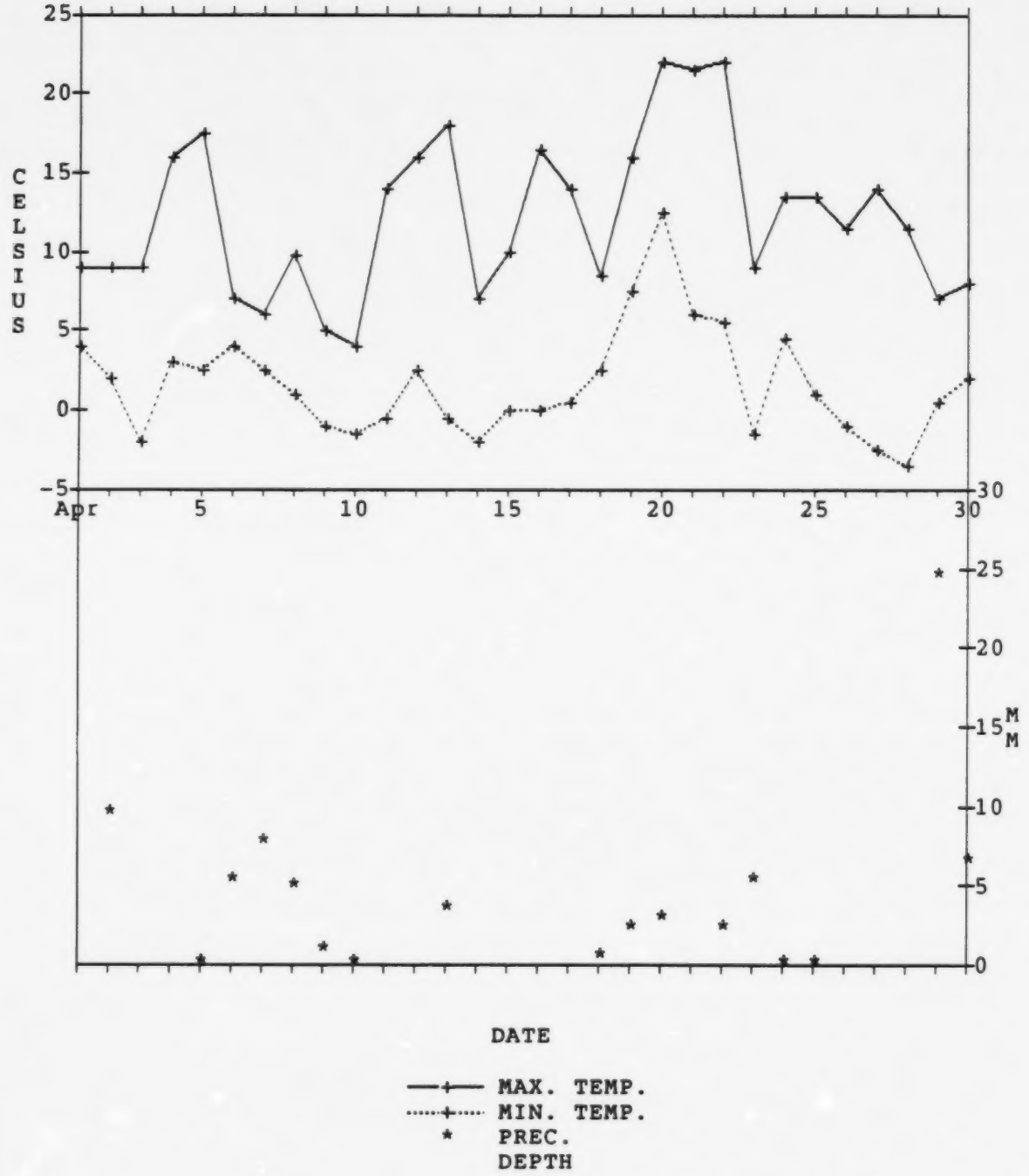


FIG. 58 PRECIPITATION PH AND DEPTH IN THE MERSEY RIVER AREA DURING WINTER 1986-87

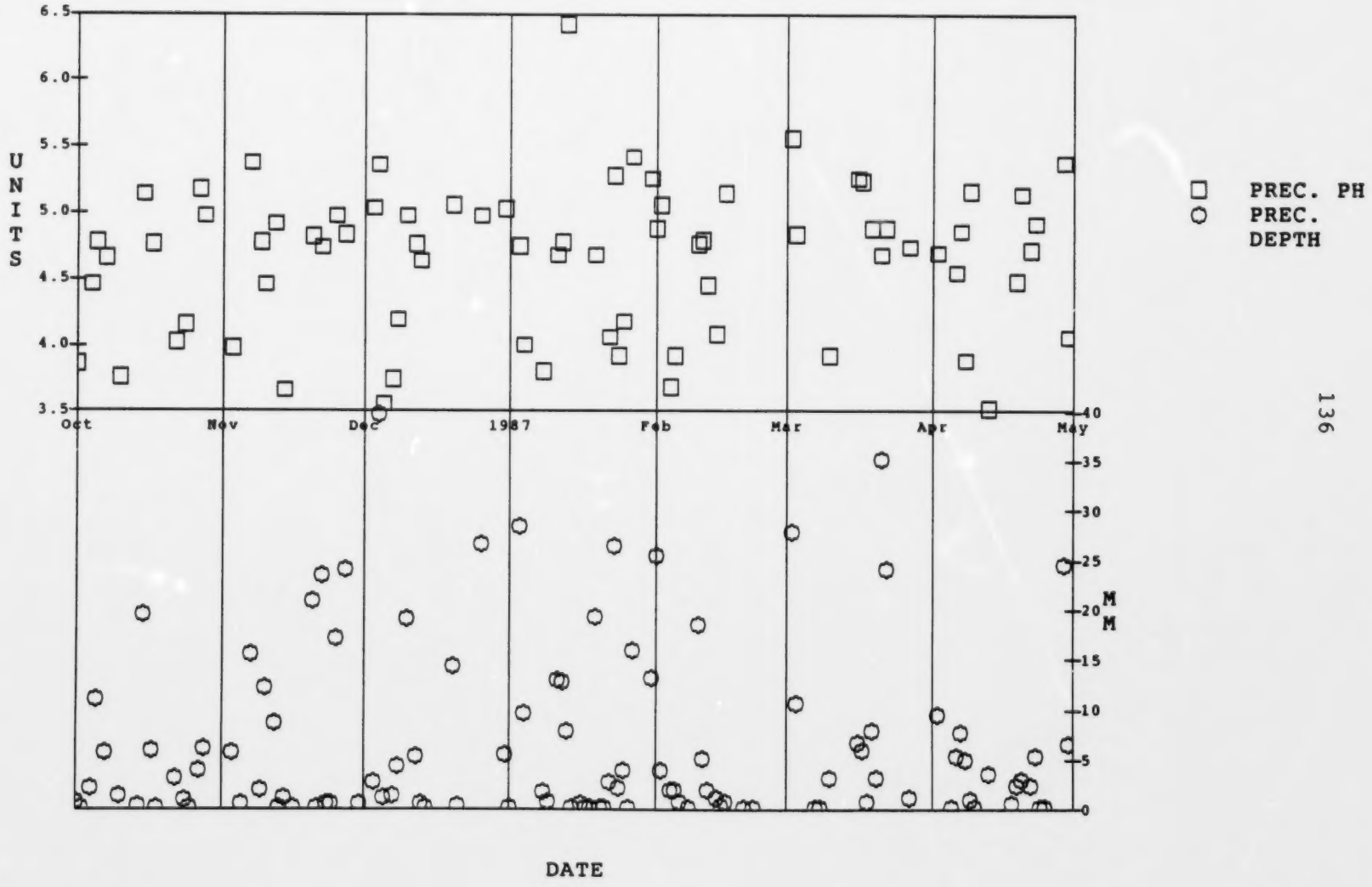


FIG. 59A. SNOW HYDROGEN ION CONCENTRATIONS AT THE CAPMON SITE IN THE MERSEY RIVER AREA DURING WINTER 1986-87

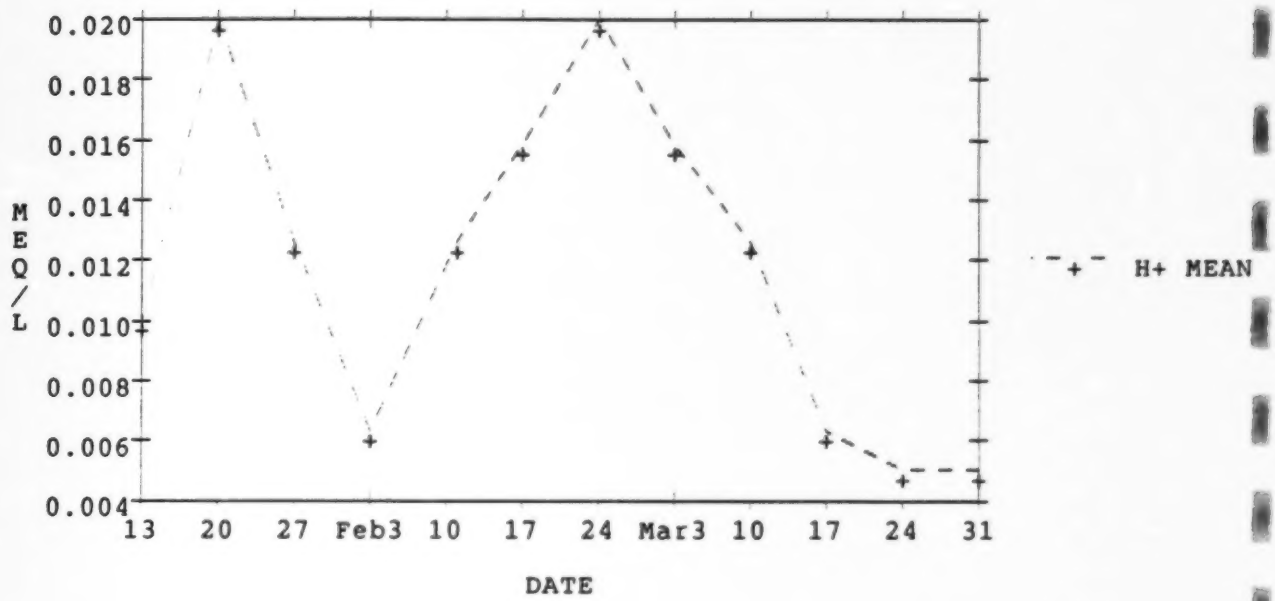


FIG. 59B. SNOW NITRATE-NITRITE AND SULPHATE ION CONCENTRATIONS AT THE CAPMON SITE IN THE MERSEY RIVER AREA DURING WINTER 1986-87

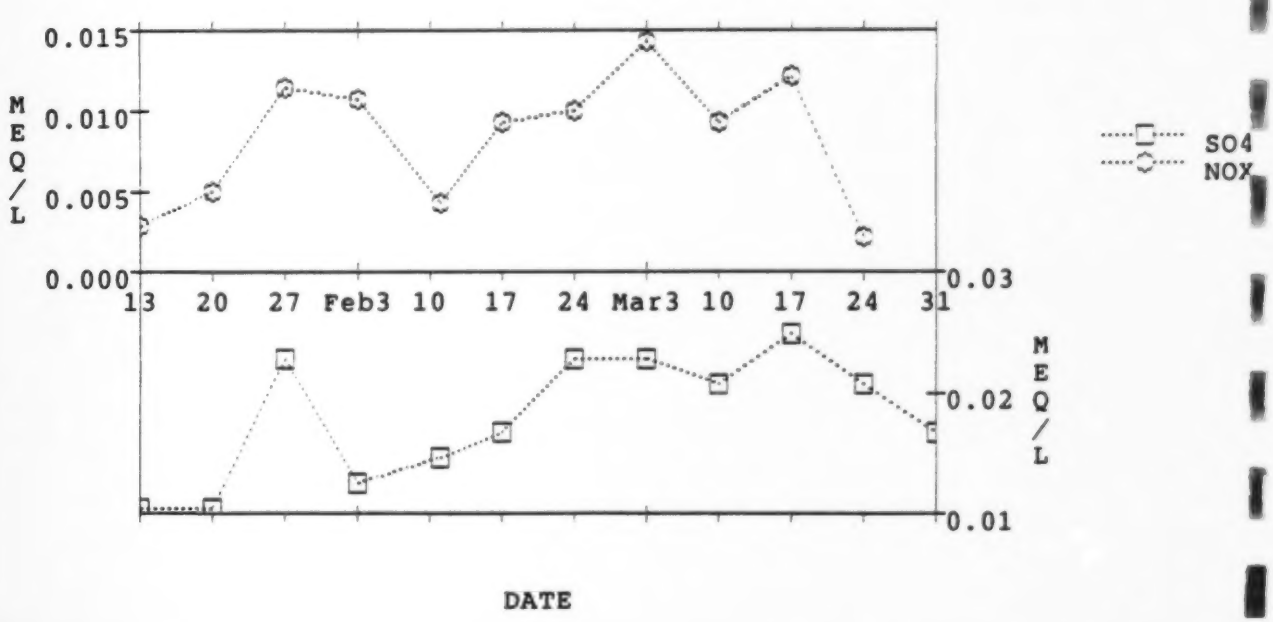


FIG. 60 HYDROGEN ION CONCENTRATIONS IN THE MERSEY RIVER DURING MARCH 20-25 1987

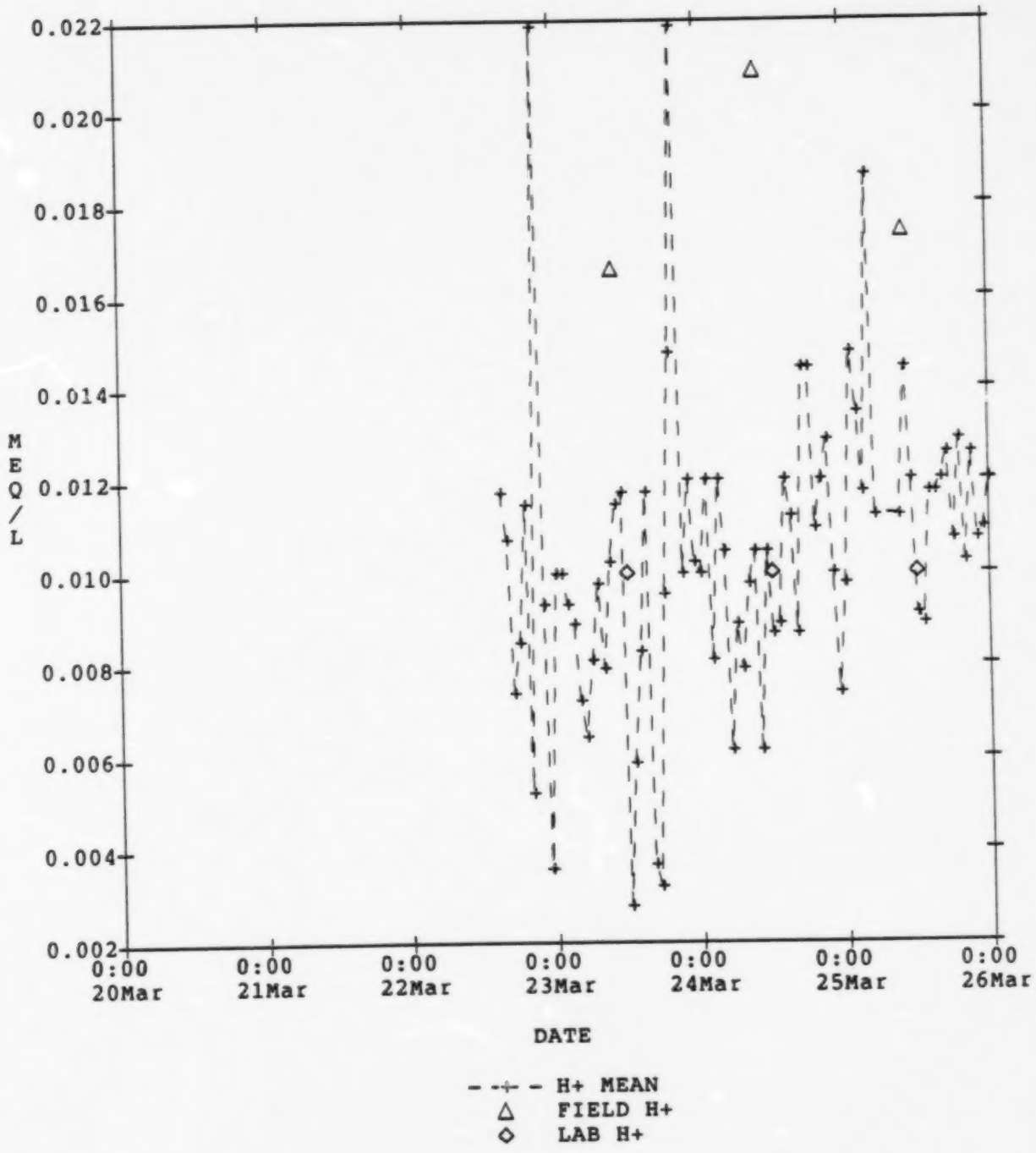


FIG. 61 HYDROGEN ION CONENTRATIONS IN THE MERSEY RIVER DURING MARCH 26-31 1987

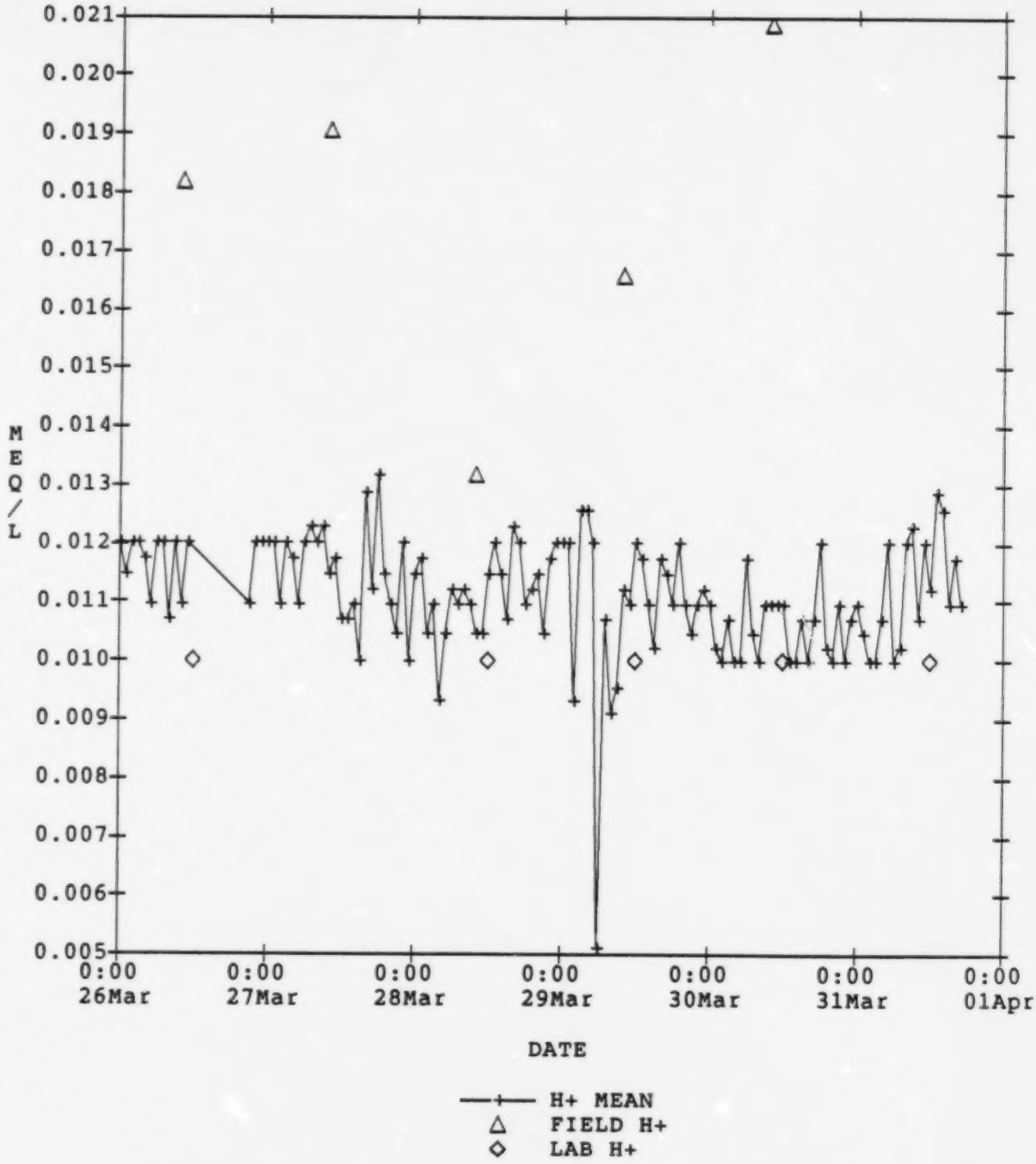


FIG. 62 HYDROGEN ION CONCENTRATIONS IN THE MERSEY RIVER DURING APRIL 1-5 1987

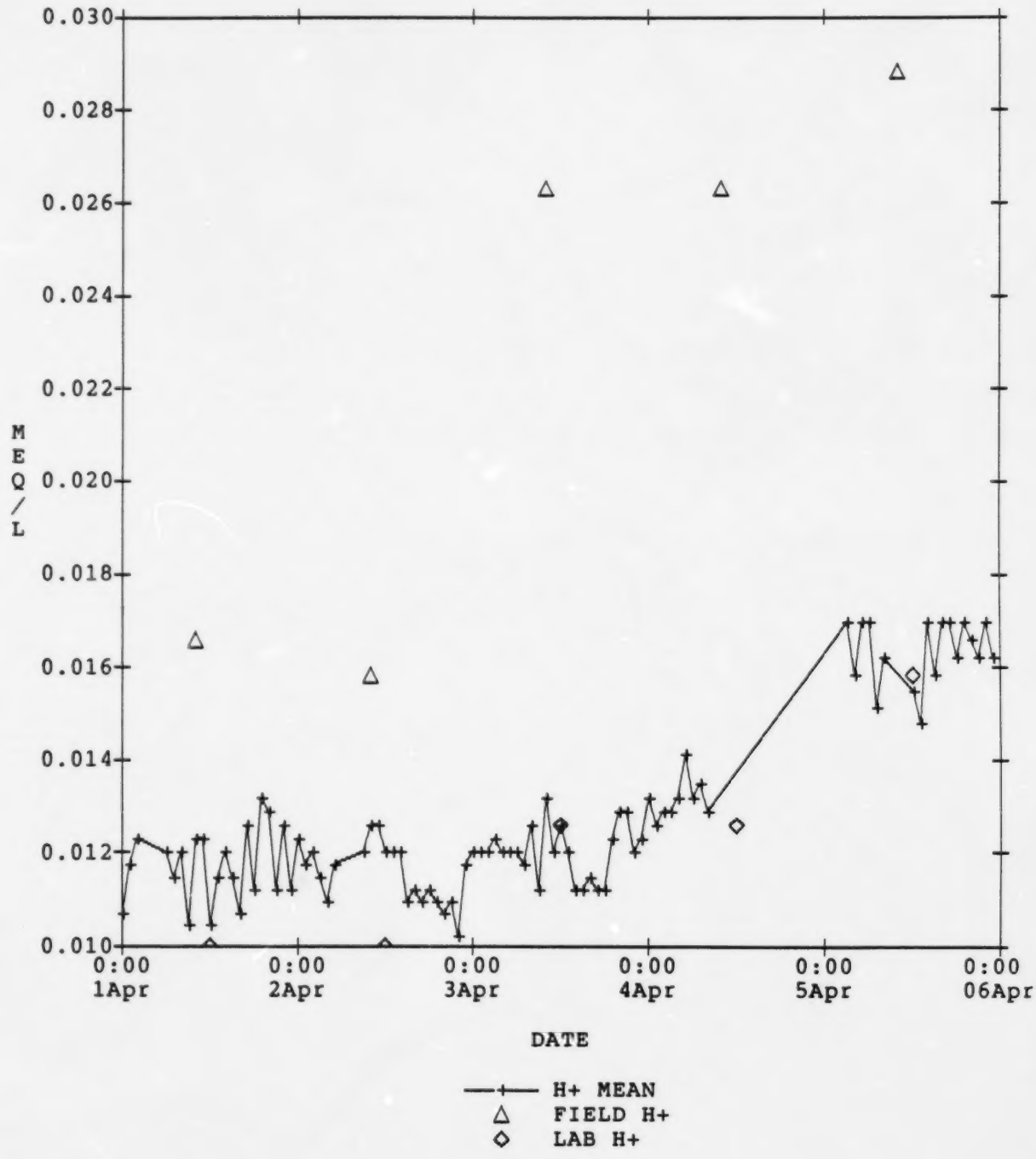


FIG. 63 HYDROGEN ION CONCENTRATIONS IN THE MERSEY RIVER DURING APRIL 6-11 1987

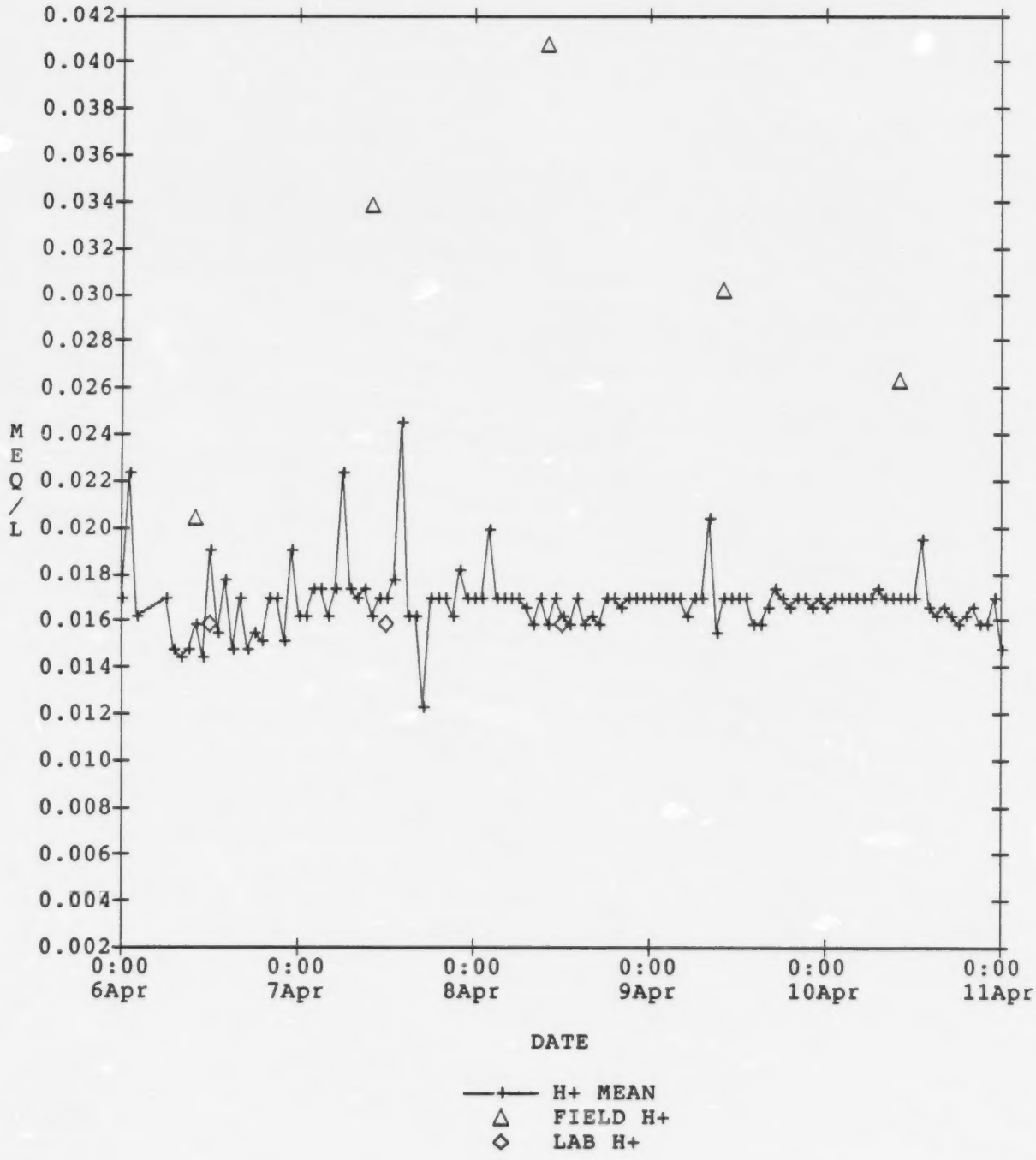


FIGURE 64: COMPARISON OF FIELD AND LABORATORY pH VALUES FOR THE MERSEY RIVER

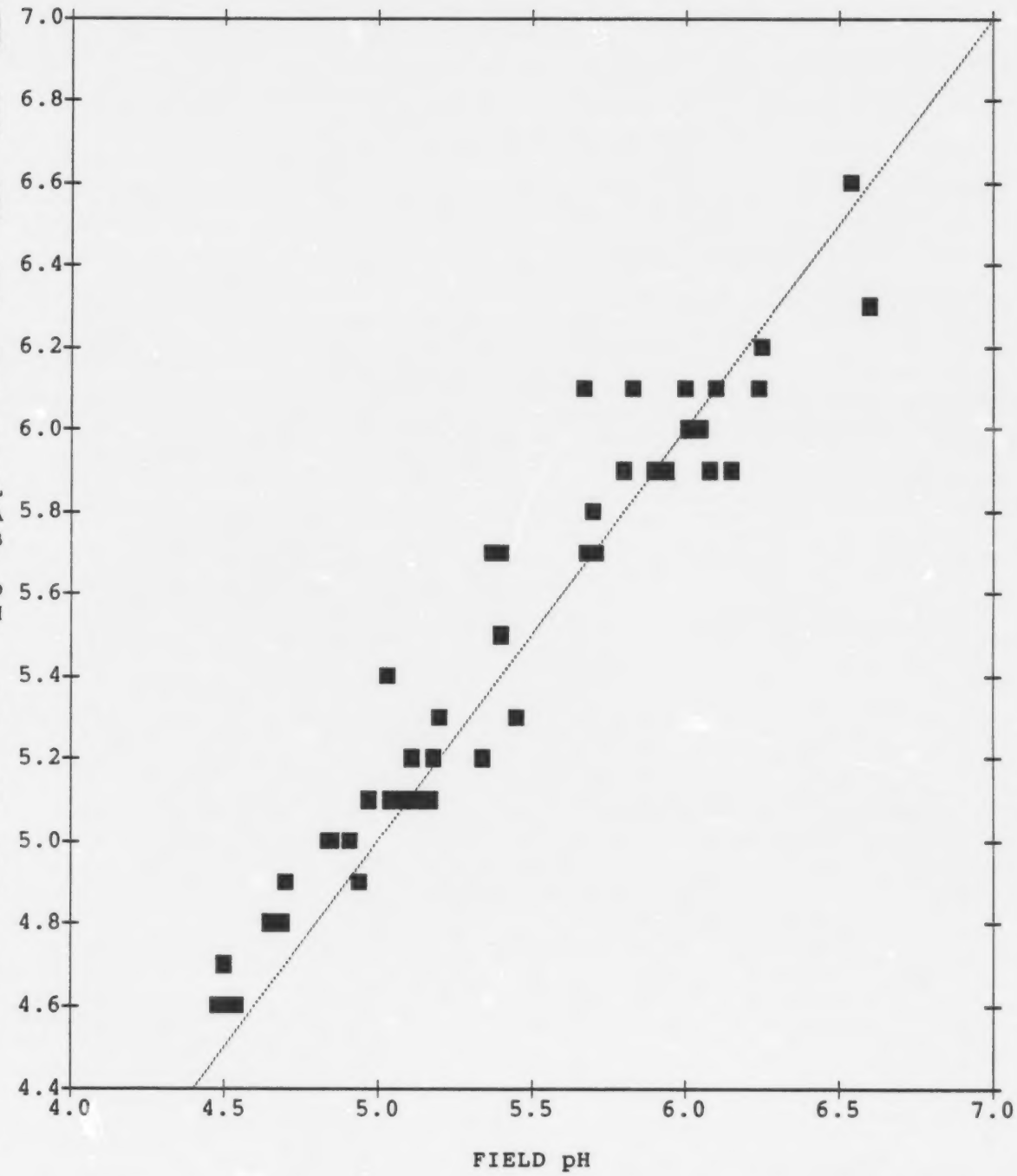


FIG. 65a HYDROGEN ION CONCENTRATIONS IN THE MERSEY RIVER DURING OCTOBER 1986

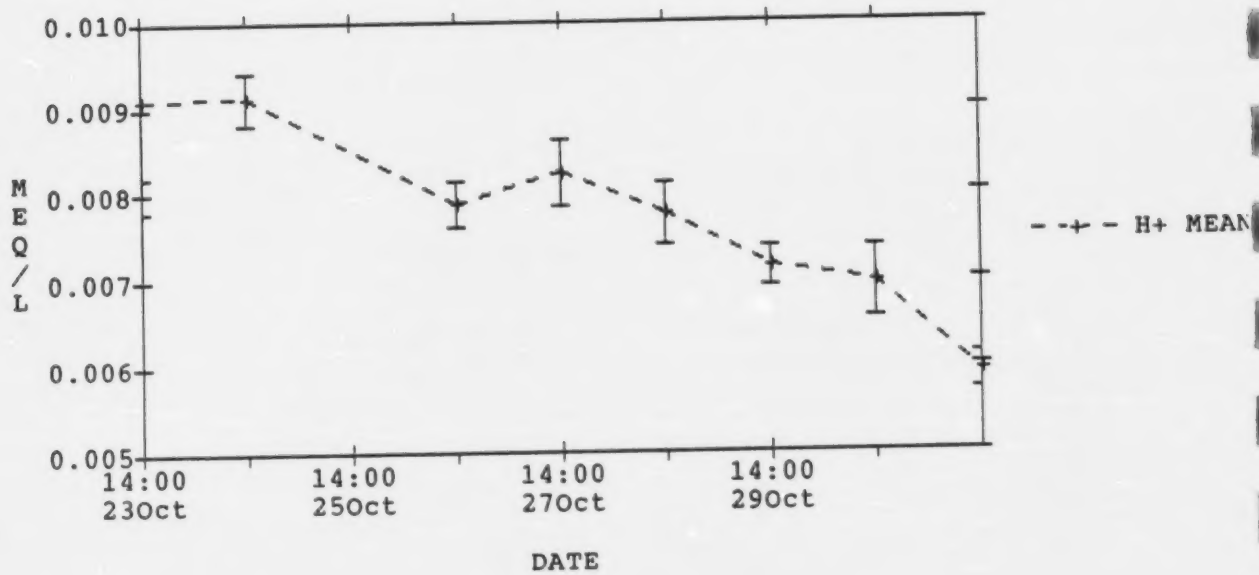


FIG. 65b NITRATE-NITRITE AND SULPHATE IONS CONCENTRATIONS IN THE MERSEY RIVER DURING OCTOBER 1986

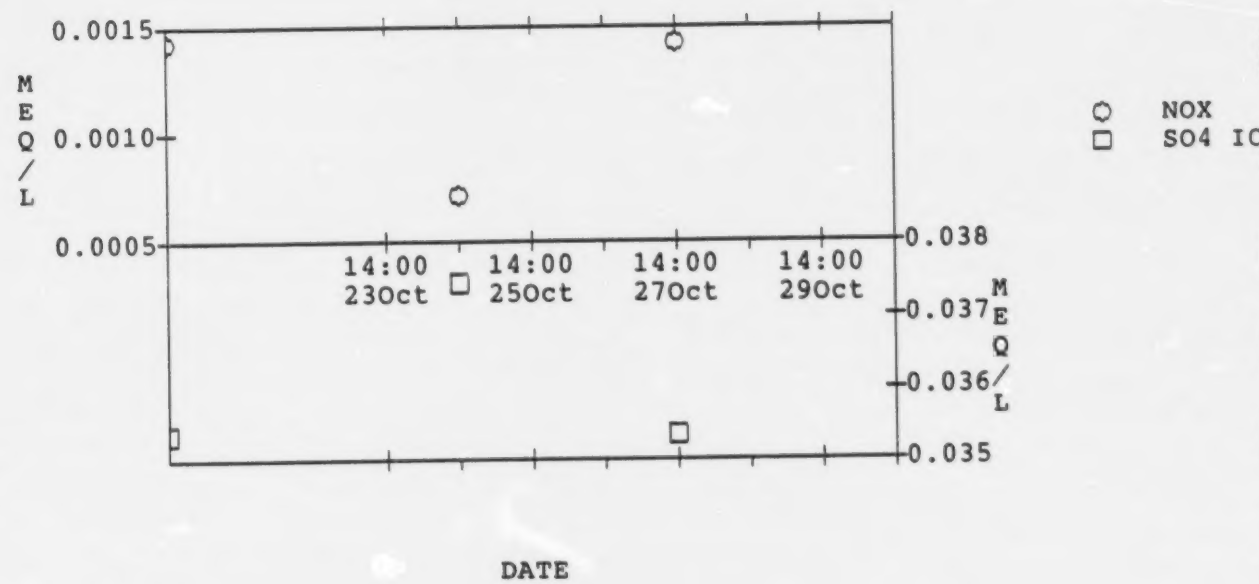


FIG. 66a HYDROGEN ION CONCENTRATIONS IN THE MERSEY RIVER DURING NOVEMBER 1986

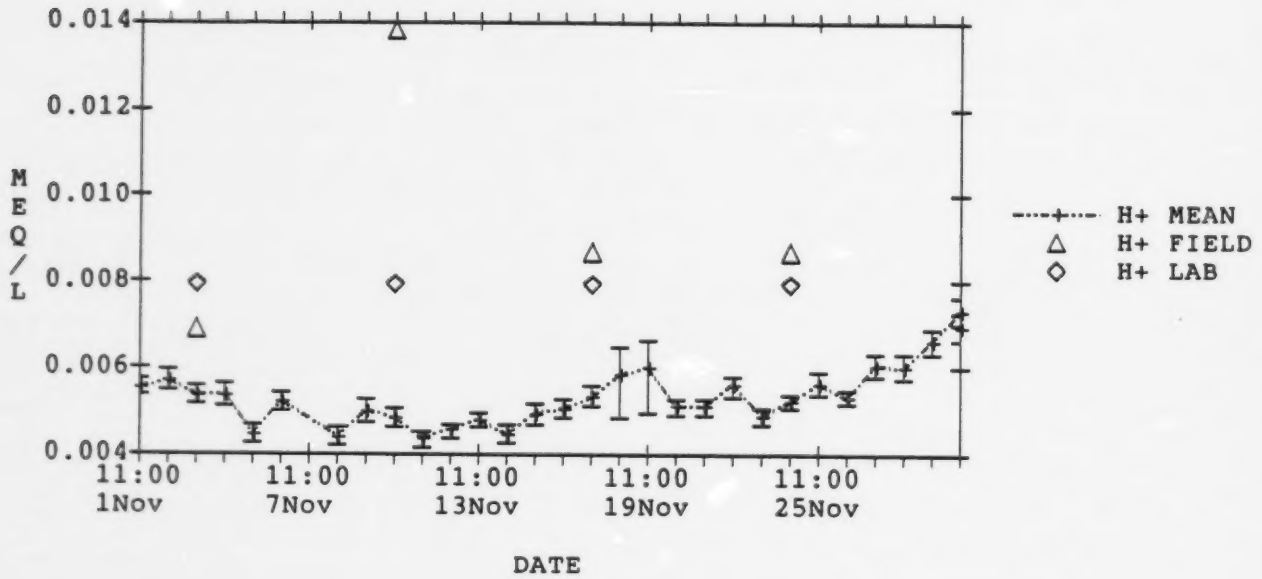


FIG. 66b NITRATE-NITRITE AND SULPHATE IONS CONCENTRATIONS IN THE MERSEY RIVER DURING NOVEMBER 1986

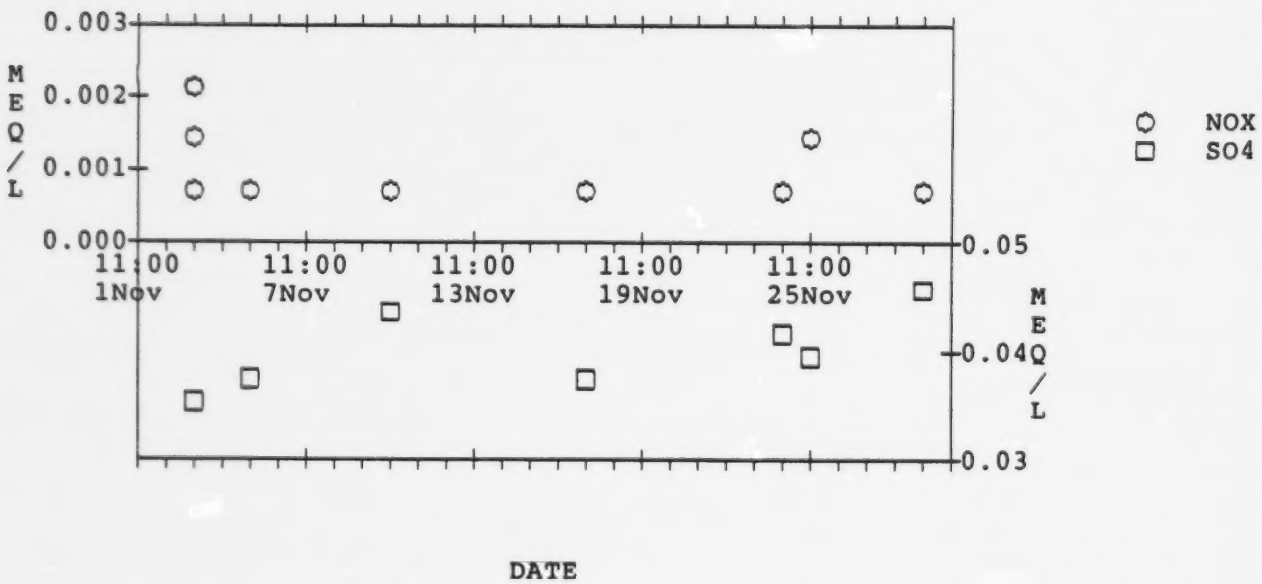


FIG. 67a HYDROGEN ION CONCENTRATIONS IN THE MERSEY RIVER DURING DECEMBER 1986

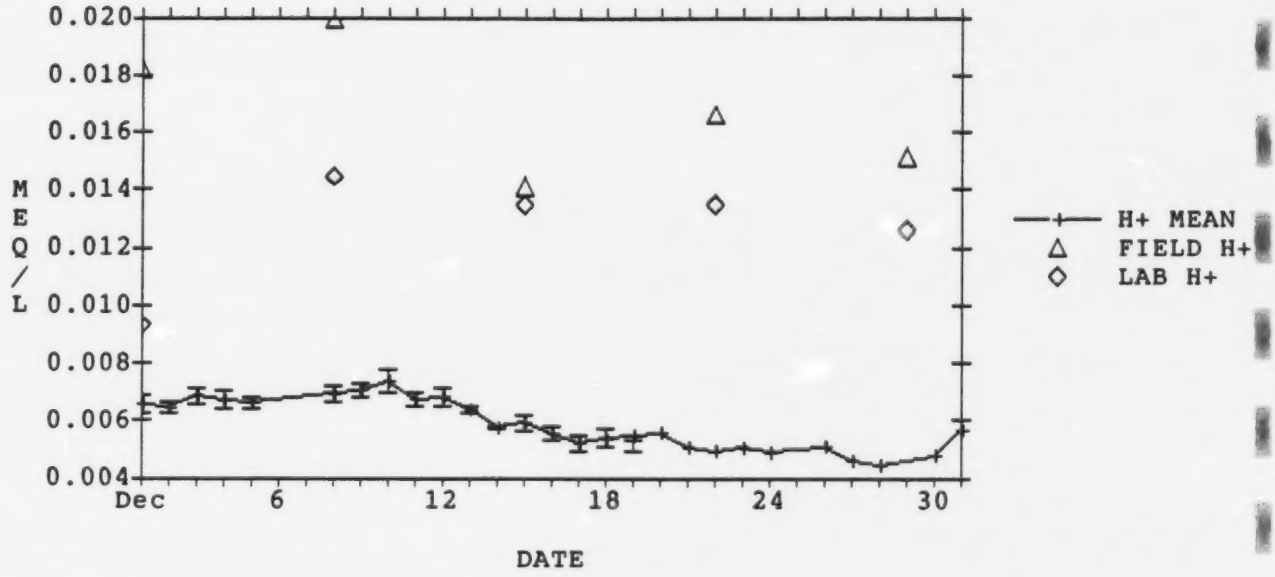


FIG. 67b NITRATE-NITRITE AND SULPHATE IONS CONCENTRATIONS IN THE MERSEY RIVER DURING DECEMBER 1986

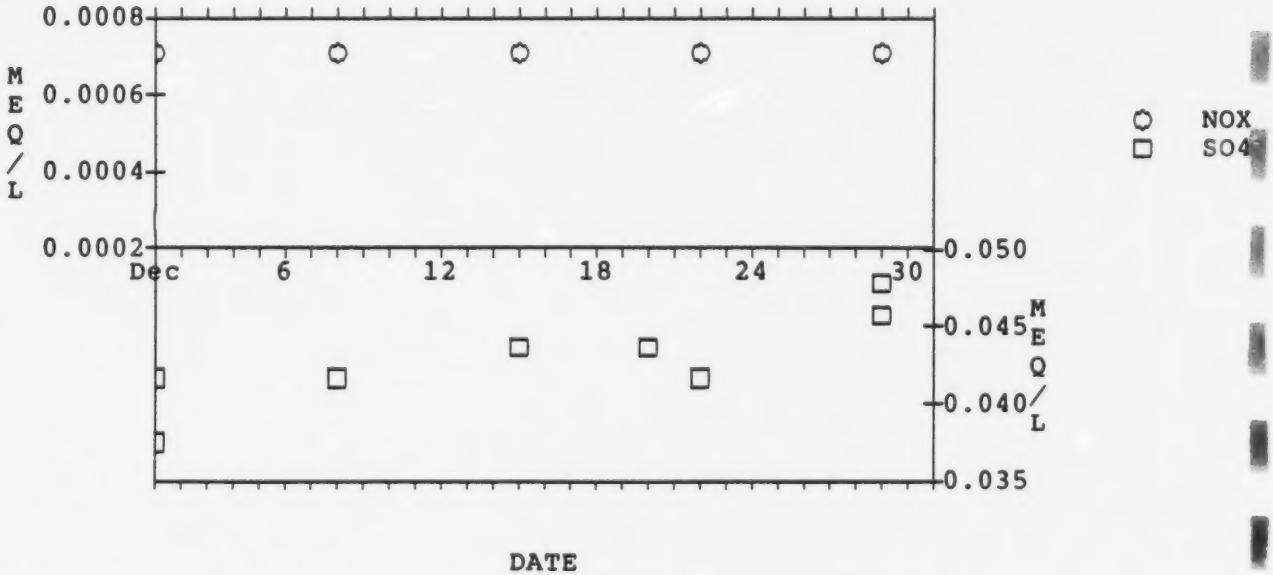


FIG. 68a HYDROGEN ION CONCENTRATIONS IN THE MERSEY RIVER DURING JANUARY 1987

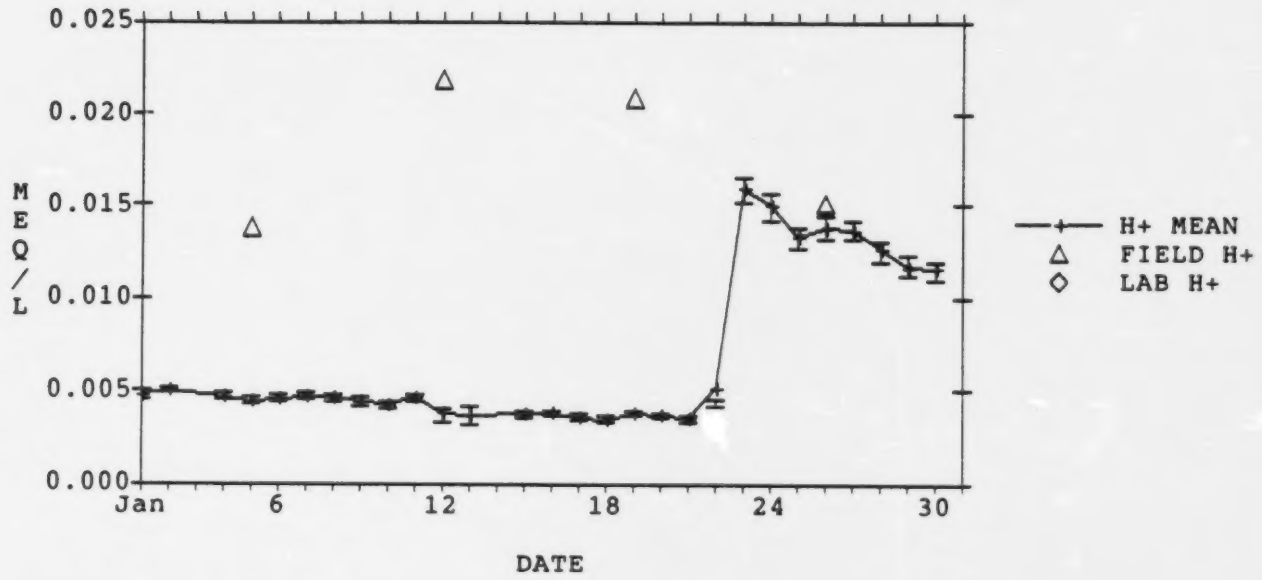


FIG. 68b NITRATE-NITRITE AND SULPHATE IONS CONCENTRATIONS IN THE MERSEY RIVER DURING JANUARY 1987

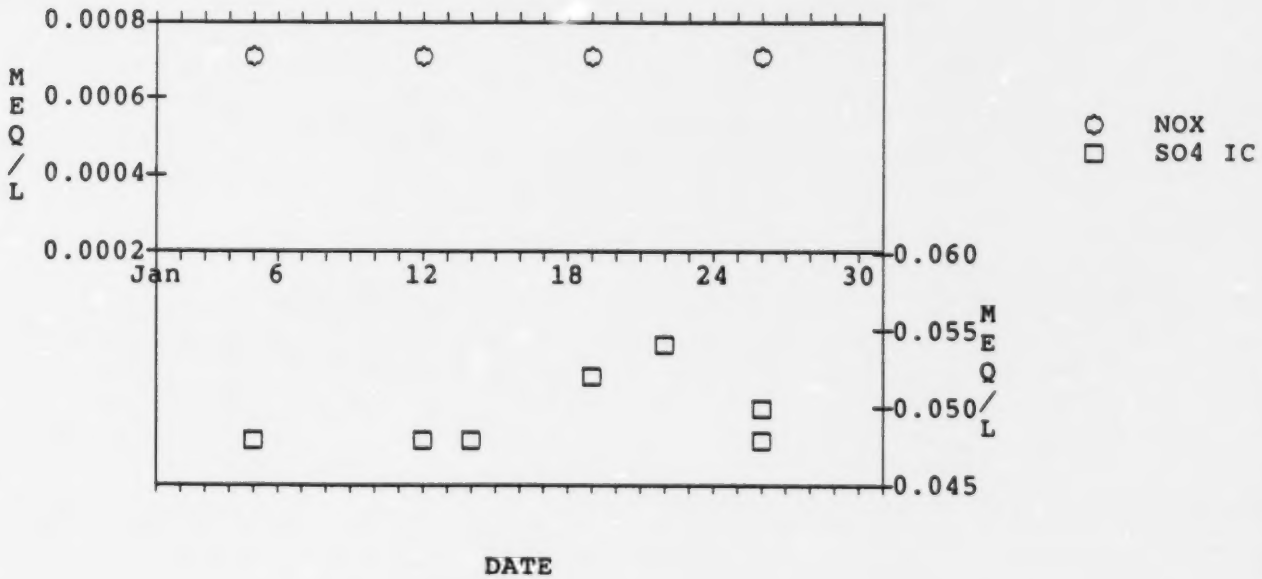


FIG. 69a HYDROGEN ION CONCENTRATIONS IN THE MERSEY RIVER DURING FEBRUARY 1987

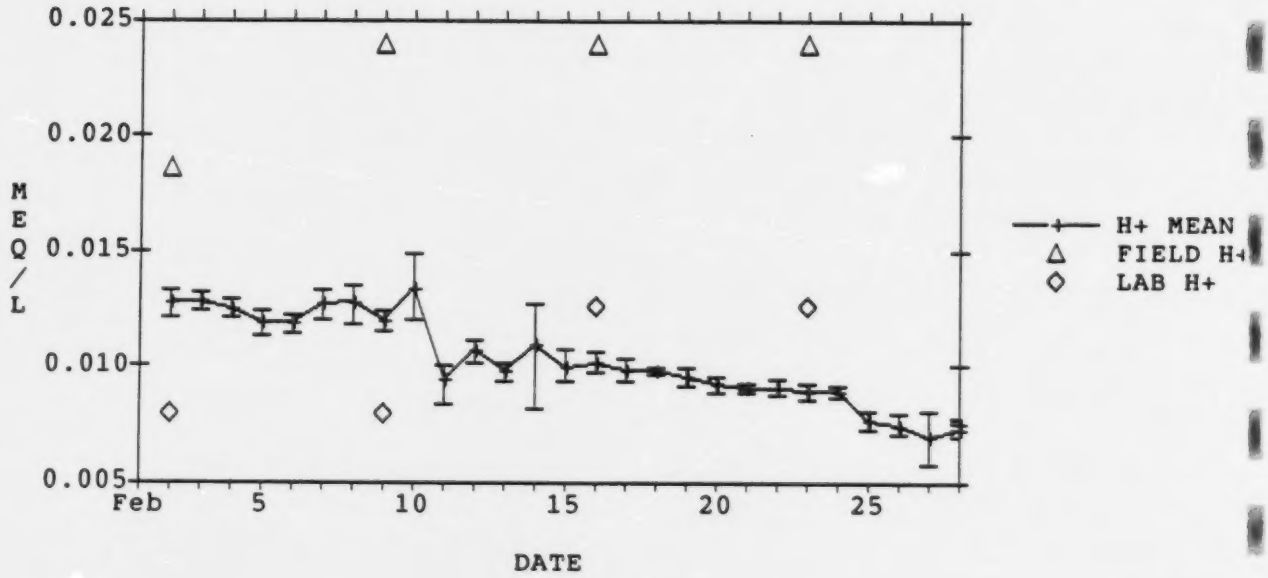


FIG. 69b NITRATE-NITRITE AND SULPHATE IONS CONCENTRATIONS IN THE MERSEY RIVER DURING FEBRUARY 1987

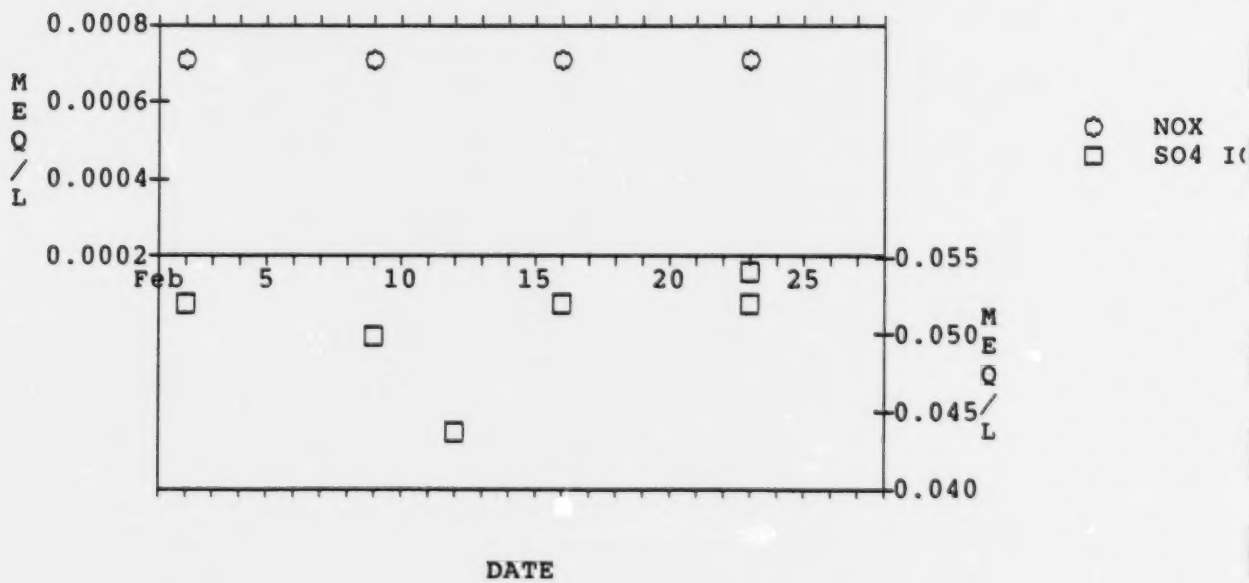


FIG. 70a HYDROGEN ION CONCENTRATIONS IN THE MERSEY RIVER DURING MARCH 1987

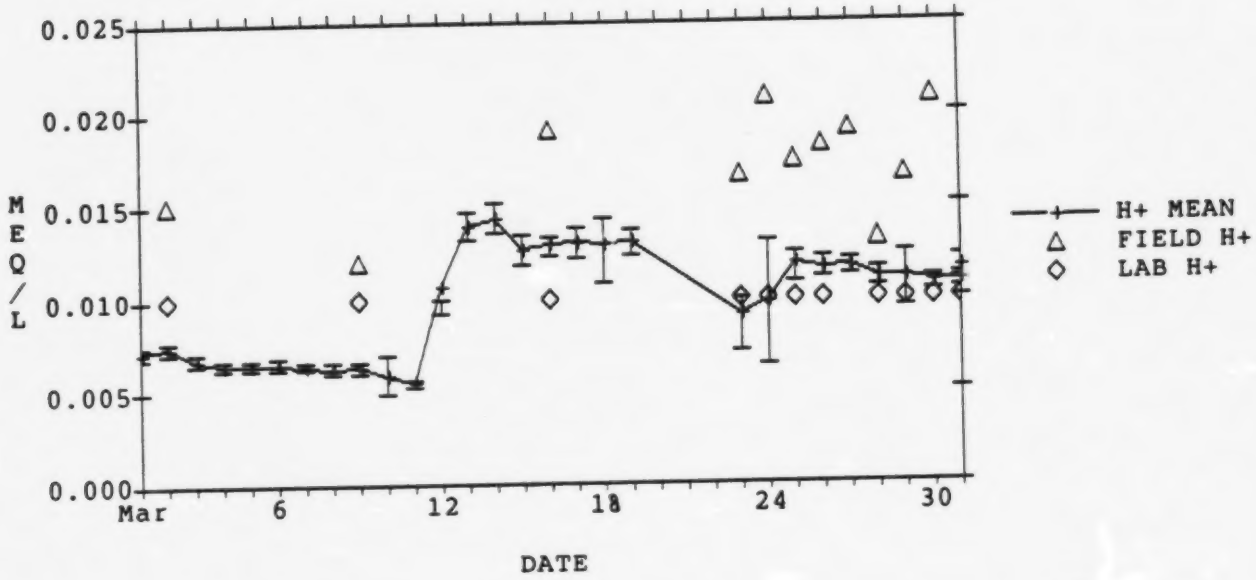


FIG. 70b NITRATE-NITRITE AND SULPHATE IONS CONCENTRATIONS IN THE MERSEY RIVER DURING MARCH 1987

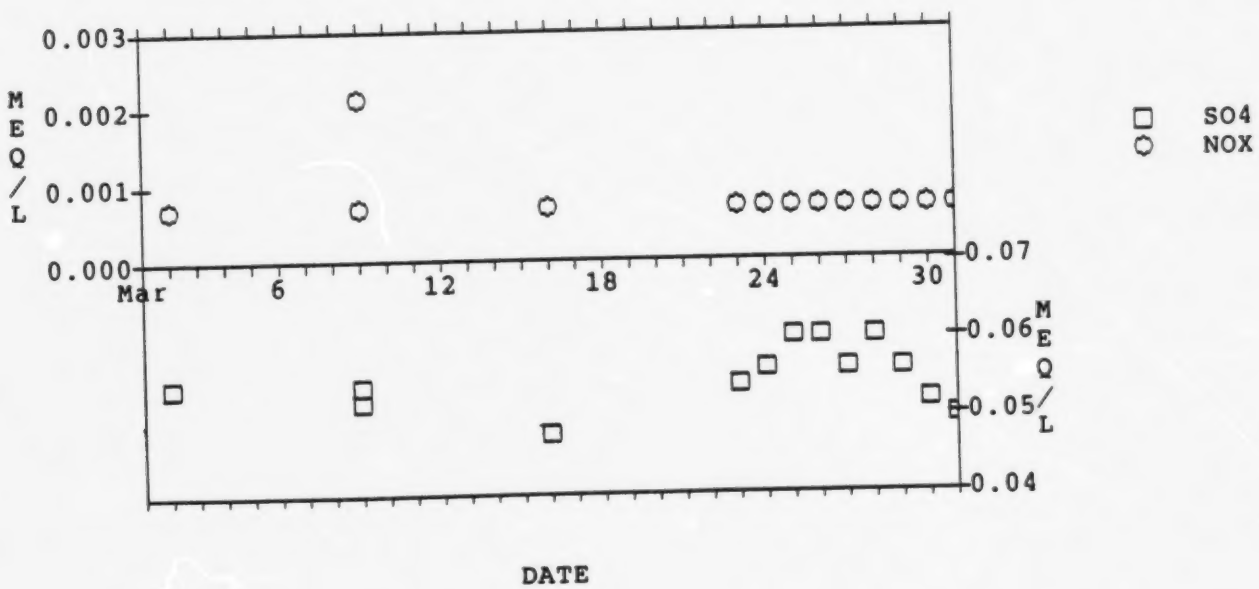


FIG. 71a HYDROGEN ION CONCENTRATIONS IN THE MERSEY RIVER DURING APRIL 1987

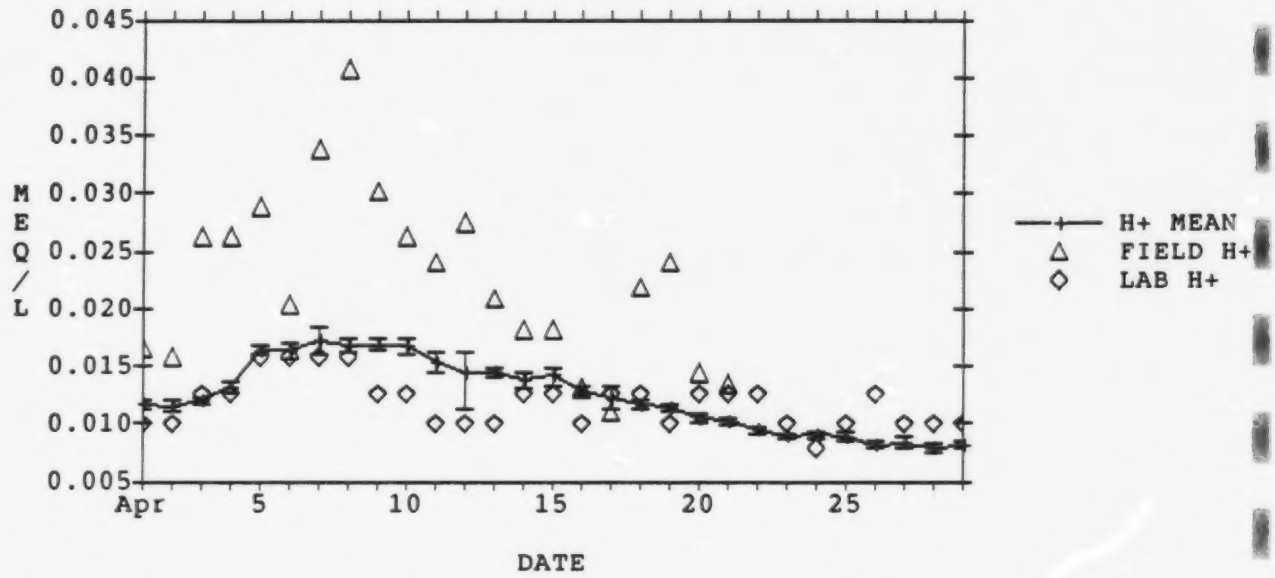


FIG. 71b NITRATE-NITRITE AND SULPHATE IONS CONCENTRATIONS IN THE MERSEY RIVER DURING APRIL 1987

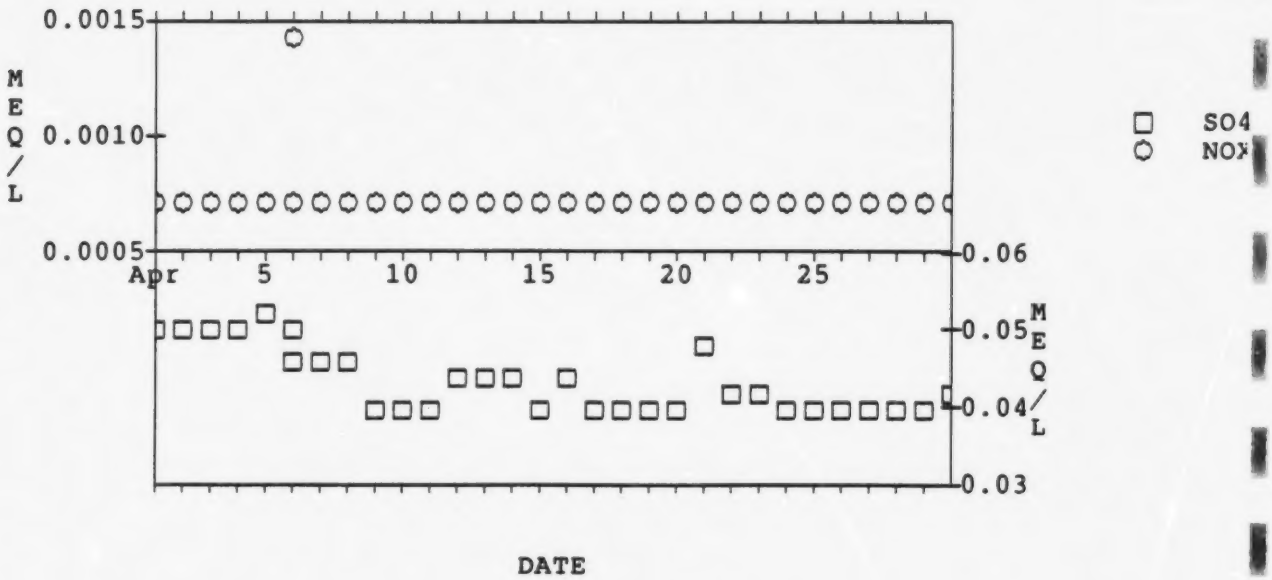
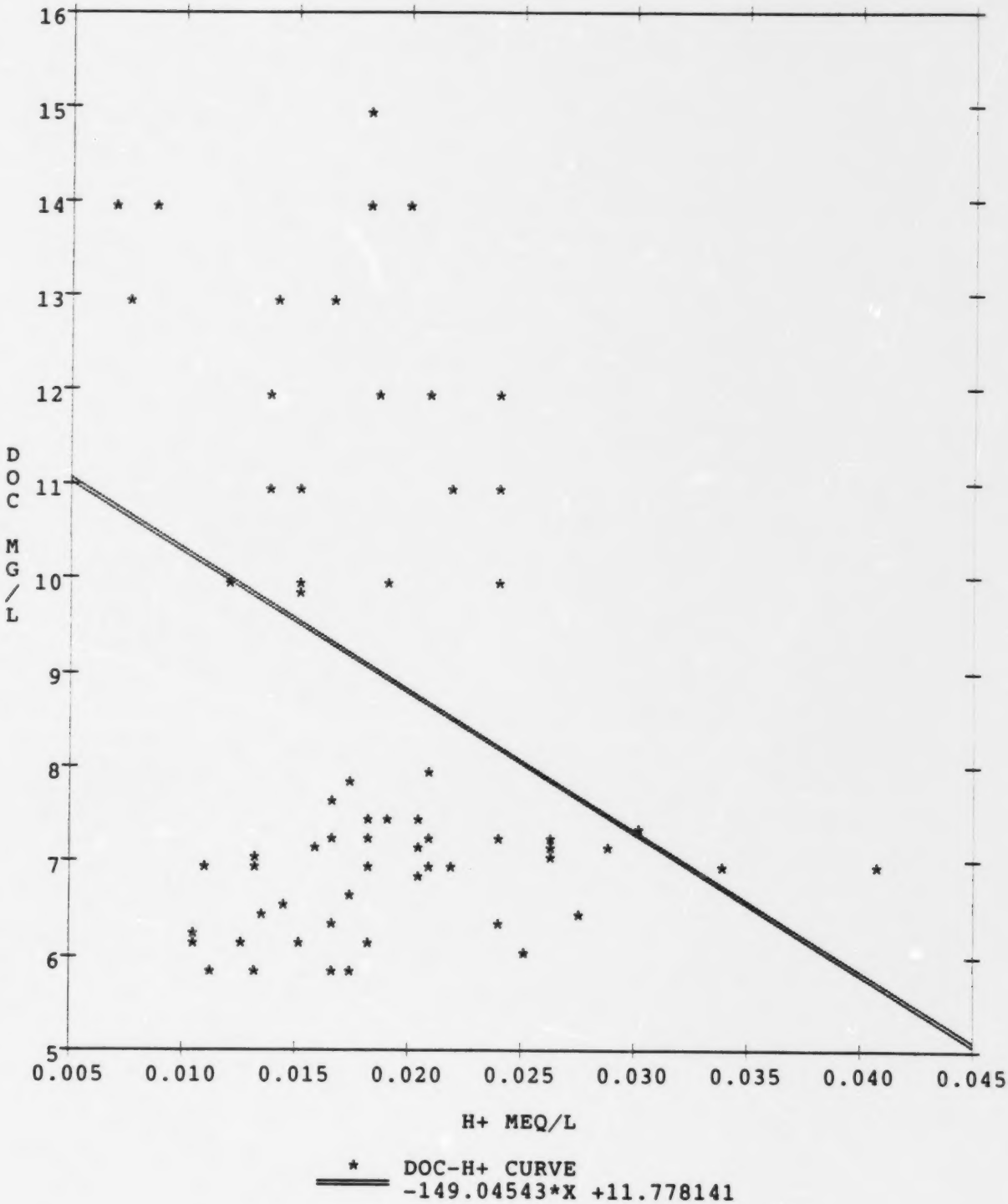


FIG. 72. DOC AND FIELD HYDROGEN ION CURVE FROM THE MERSEY RIVER DATA DURING WINTER 1986-87



11. APPENDIX 1

Performance Specifications of the Montedoro-Whitney Type A Water Quality Probe

Type A

Conductivity:	3 Electrode Type
Hi Range:	1 - µmhos - 65 mmhos
Accuracy:	1/2% of f.s. or 1% of reading
Resolution:	10 µmhos
Lo Range:	5 µmhos - 20 mmhos
Accuracy:	1% of f.s.
Resolution:	1 µmho
Temperature Compensation:	-5°C to +45°C corrected to NaCl curve at 25°C Selection points for optimum compensation are 1°/oo, 10°/oo, and 40°/oo salinity. Uncompensated operation also possible.
Response Time:	Conductivity instantaneous. Temperature 10 seconds
Temperature:	Thermistor
Range:	-5°C to +45°C
Accuracy:	0.1°C
Resolution:	0.01°C
Response Time:	10 seconds typical

Dissolved Oxygen: Polarographic Sensor

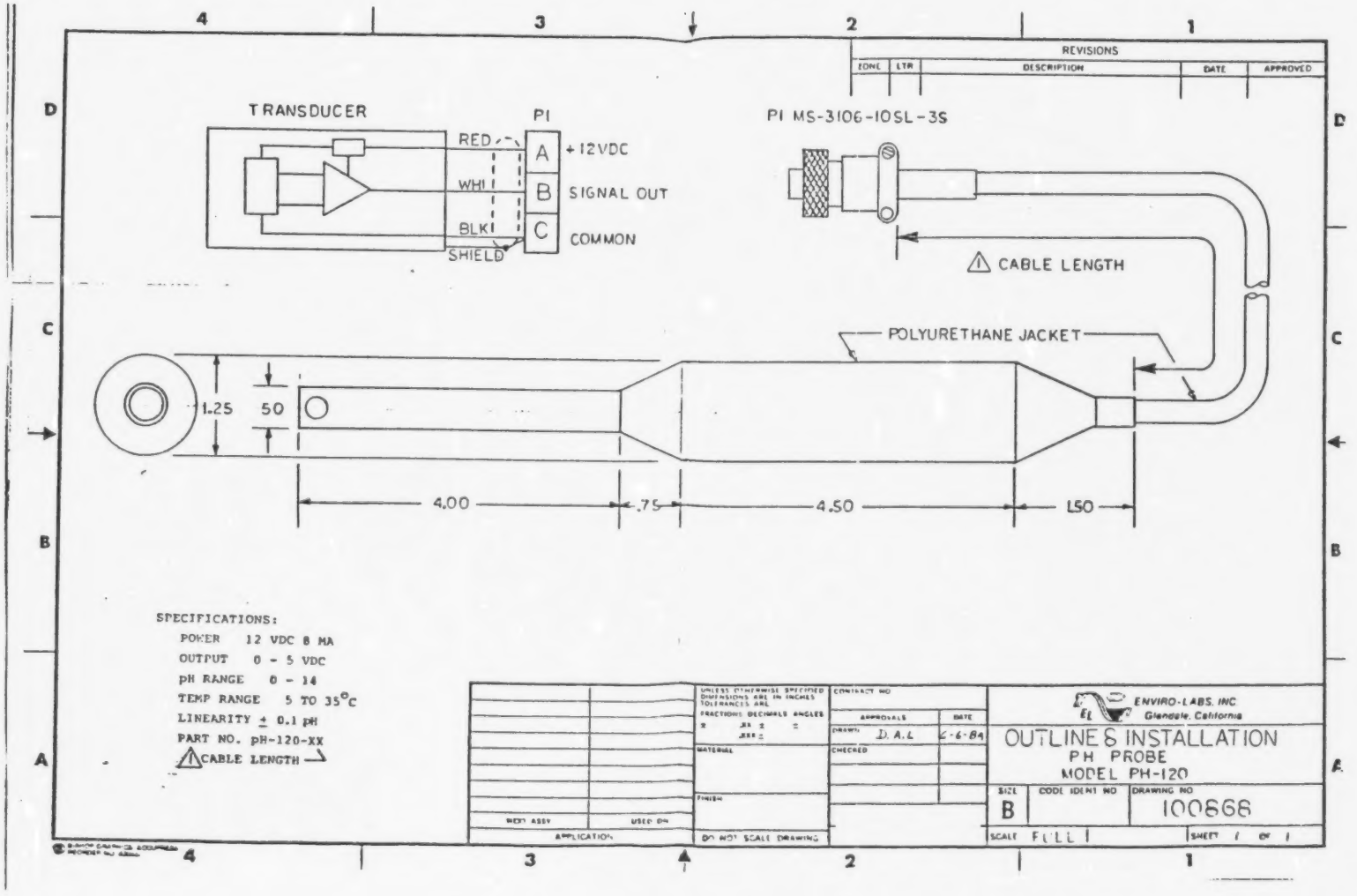
Range:	0-20 ppm
Accuracy:	0.1 ppm
Resolution:	0.01 ppm
Response time to D.O. Change:	3 seconds typical
Response time to Temp. Change:	30 seconds typical
Temperature Compensation:	-5°C to +45°C
Pressure compensated to any Depth.	

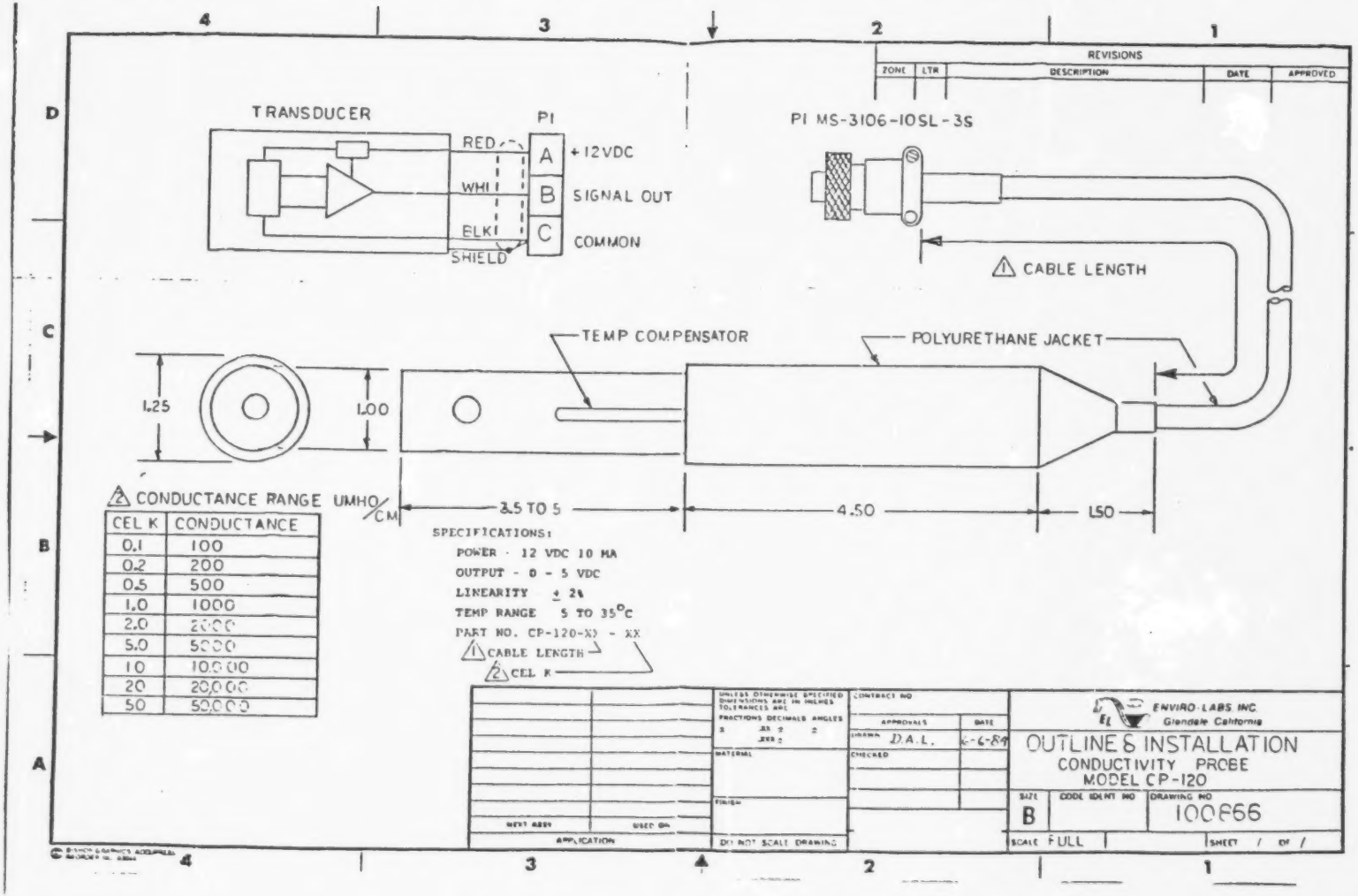
pH: Combination Electrode $485.00

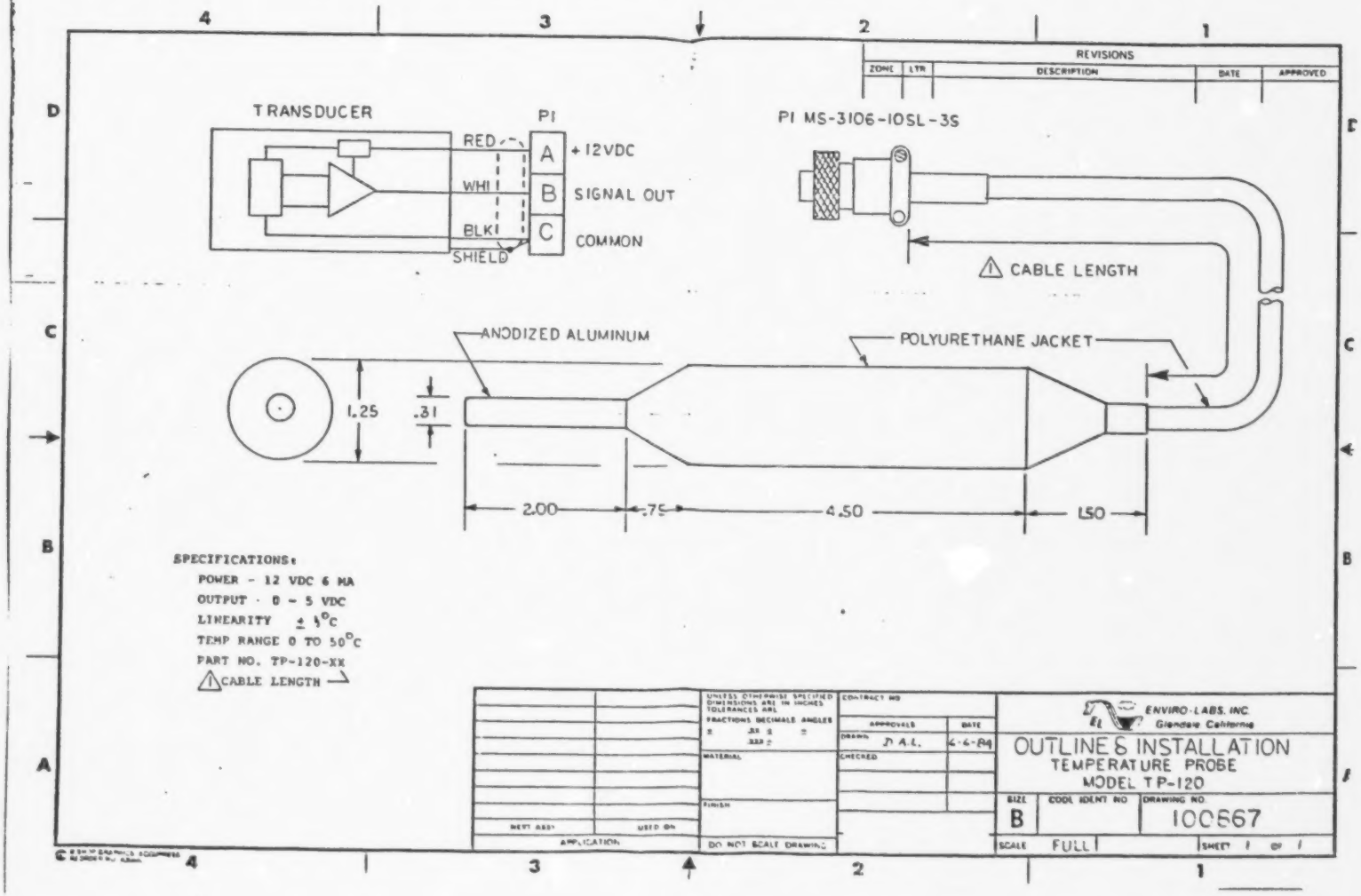
Range:	0-14
Accuracy:	0.05 pH
Resolution:	0.001 pH
Temperature Compensation:	-5°C to +45°C
Response time to pH Change:	5 seconds
Response Time to Temp. Change:	10 seconds

12. APPENDIX 2

Performance Sepcifications, Probe Outline and Installation of the Enviro-Labs Water Quality Probes


REVISIONS
ZONE LTR DESCRIPTION DATE APPROVED
TRANSDUCER
PI
RED
WHI
BLK
SHIELD
A +12VDC
B SIGNAL OUT
C COMMON
PI MS-3106-10SL-3S
⚠ CABLE LENGTH
POLYURETHANE JACKET
1.25
50
4.00
.75
4.50
1.50
SPECIFICATIONS:
POWER 12 VDC 8 MA
OUTPUT 0 - 5 VDC
pH RANGE 0 - 14
TEMP RANGE 5 TO 35°C
LINEARITY ± 0.1 pH
PART NO. pH-120-XX
⚠ CABLE LENGTH
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
MATERIAL
FINISH
DO NOT SCALE DRAWING
CONTRACT NO
APPROVALS DATE
DRAWN D.A.L 6-6-84
CHECKED
ENVIRO-LABS, INC
Glendale, California
OUTLINE & INSTALLATION
PH PROBE
MODEL PH-120
SIZE B
CODE IDENT NO
DRAWING NO 100668
SCALE FULL
SHEET 1 OF 1
NEXT ASSY
USED ON
APPLICATION


REVISIONS
ZONE LTR DESCRIPTION DATE APPROVED
TRANSDUCER
PI
RED
WHI
BLK
SHIELD
A +12VDC
B SIGNAL OUT
C COMMON
PI MS-3106-10SL-3S
1 CABLE LENGTH
TEMP COMPENSATOR
POLYURETHANE JACKET
1.25
1.00
3.5 TO 5
4.50
.50
1 CONDUCTANCE RANGE UMHO/CM
CEL K | CONDUCTANCE
0.1 | 100
0.2 | 200
0.5 | 500
1.0 | 1000
2.0 | 2000
5.0 | 5000
10 | 10,000
20 | 20,000
50 | 50,000
SPECIFICATIONS:
POWER - 12 VDC 10 MA
OUTPUT - 0 - 5 VDC
LINEARITY ± 2%
TEMP RANGE 5 TO 35°C
PART NO. CP-120-X) - XX
1 CABLE LENGTH
2 CEL K
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
MATERIAL
FINISH
DO NOT SCALE DRAWING
CONTRACT NO
APPROVALS DATE
DRAWN D.A.L. 6-6-89
CHECKED
NEXT ASSY USED ON
APPLICATION
ENVIRO-LABS INC.
Glendale California
OUTLINE & INSTALLATION
CONDUCTIVITY PROBE
MODEL CP-120
SIZE B
CODE IDENT NO
DRAWING NO 100866
SCALE FULL
SHEET 1 OF 1


REVISIONS
ZONE
LTR
DESCRIPTION
DATE
APPROVED
TRANSDUCER
PI
RED
WHI
BLK
SHIELD
A
B
C
+12VDC
SIGNAL OUT
COMMON
PI MS-3106-10SL-3S
CABLE LENGTH
ANODIZED ALUMINUM
POLYURETHANE JACKET
1.25
.31
2.00
.75
4.50
1.50
SPECIFICATIONS:
POWER - 12 VDC 6 MA
OUTPUT - 0 - 5 VDC
LINEARITY ± 1°C
TEMP RANGE 0 TO 50°C
PART NO. TP-120-XX
CABLE LENGTH
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE
FRACTIONS DECIMAL ANGLES
MATERIAL
FINISH
DO NOT SCALE DRAWING
CONTRACT NO
APPROVED
DATE
DRAWN
D.A.L.
6-6-84
CHECKED
ENVIRO-LABS, INC.
Glendale California
OUTLINE & INSTALLATION
TEMPERATURE PROBE
MODEL TP-120
SIZE
B
COOL IDENT NO.
DRAWING NO.
100567
SCALE
FULL
SHEET 1 OF 1

13. APPENDIX 3

Correction equations found for the parameter curves of the Big Presque Isle Stream

1.	DOWS	DO = 1.022 DOWS + 0.04, mR^2 = 0.986
2.	DO MW	DO = .758 DOMW - 1.67, mR^2 = 0.983
3.	Cond E	no correction
4.	Cond MW	Cond = 0.93 Cond MW (1 + 0.02 (25 - T)) T = water temperature
5.	pHE	pH = 0.445 · pHE + 3.59, mR^2 = 0.783
6.	pH MW	pH = pH MW - 0.24, mR^2 = 0.889
7.	WT	no correction
8.	AT	no correction
9.	PAR	no correction